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(Continued from Page 96)

Morning Session, Thursday, December 29, 1910

PRESIDENT SANDERSON: The first paper will be the "Economic Importance of *Stictocephala*, by Herbert Osborn.

ECONOMIC IMPORTANCE OF STICTOCEPHALA

By HERBERT OSBORN, *Ohio State University*

This genus has not generally been considered of any particular economic importance, but some instances which have come up within the last few months, and evidences secured from various sources, prove that it has an economic importance that cannot longer be overlooked. It may be premised that the species of this genus are many of them widely distributed throughout the country, and in some cases occur in considerable abundance, so that if they increase in number, and at the same time direct their attacks toward any important crop, they may easily become of considerable importance from an economic standpoint.

One of the most widely distributed species is *Stictocephala festina* Say, which has a distribution throughout the entire southern and southwestern part of the United States. This species has been known since its early description by Thomas Say, has been a very common insect

in collections and is likely to appear in almost every collection from its area of distribution. Heretofore, however, there appears to have been no definite record of its attack upon any important crop, and, so far as I know, no suggestion that it may have a distinct economic importance. During the past year it has appeared in my own collections in a number of locations, and especially upon alfalfa and clover, so that it has seemed possible to have a distinct importance. Moreover, during the last few months a number of specimens have been sent to me through the Bureau of Entomology with the information that the insect was injuring alfalfa, so that there seems no longer any question as to its having a definite relation to this crop. The mode of attack of the insect appears to be, in general, the puncturing and sucking of sap from the stems, but in some instances it has been observed that the punctures have been made in a series surrounding some of the stems, and as a result of this attack the plants above the point of puncture wilt and die, so that the injury is very evident.

As the most definite record in hand I may reproduce the following extracts from letters to the Bureau of Entomology from Mr. R. A. Cushman:

TALLULAH, LA., August 27, 1910.

Dr. C. W. Edgerton, plant pathologist of the Louisiana Experiment Station paid us a visit yesterday, during which I spent several hours with him driving over the country and inspecting the alfalfa for diseases. He called my attention to a peculiar girdling of the stems, which he says is caused by a Membracid. I am sending you under separate cover both the adults and nymphs of this species for determination. Doctor Edgerton tells me that he has proved beyond a doubt that this insect is responsible for the injury mentioned by placing alfalfa plants in cages of sterile soil in which some of the insects were confined. The injury appeared over night. His conclusions are further proved by the fact that microscopic examinations of sectioned stems show no disease and that none of the tissue of the plant is removed by the injury but simply shrunken, due to the removal of the plant juices at that point. I have written of this in some detail for the reason that the idea of a sucking insect causing an injury of this character is new to me. I am also sending some stems of alfalfa showing the injury. . . .

September 1, 1910.—Extract from letter of above date: . . . I might add in this connection that it seems to be the immature insects which do the most damage. In regard to the extent of the injury to alfalfa in this neighborhood, so far as my own observations go, I should say that it is rather a serious pest. As we walked through the field the other day the adults would jump up in great abundance and we had no difficulty in finding the nymphs and the injury. The injured stems have a rather characteristic yellowish appearance and these were of rather frequent occurrence, while the newly girdled stems were abundant. However, my observations cover only a short time spent in one field, and I would not, therefore, like to express an opinion as to the seriousness of the pest in this region. The alfalfa industry in the neighborhood of Tallulah embraces but a small acreage on a few plantations, the growing of that crop being still in the experimental stage, but as I find opportunity I will look further into the subject.

The life history of this species has not been followed in detail and as a general thing the form which appears in collections is the adult, and the occurrence of this form is apparently distributed pretty well through the season. However, there is sufficient evidence to indicate that the larvæ develop rather rapidly during the summer, and that they may occur on various plants, perhaps especially upon the legumes, within the range of their distribution.

It would seem from the information so far acquired that this species has under natural conditions, lived upon some of the native leguminous plants, and since the general introduction of alfalfa as a cultivated crop that it has acquired a taste for this food plant. This being the case there is considerable reason to assume that it will multiply and adapt itself still more perfectly to this food plant, so that it may become a very distinct pest throughout the region in which alfalfa is now a very important crop. So far the species has not been studied sufficiently to suggest any very definite means of control. In case the eggs are deposited in the stems of the alfalfa, a proper timing for the cutting of the crop and the consequent destruction of the eggs would appear to be a very feasible method of control. This would seem to be a very essential point for determination and one which should be easily determined in the localities where the species is of especial consequence.

Another species which is of very general distribution is *Stictocephala inermis*, which has been taken throughout a considerable range of the northern part of the United States, and which seems to occur under somewhat similar conditions as *festina*. There is so far not as definite a mass of evidence with regard to its occurrence on a particular crop, but it quite certainly is able to feed upon alfalfa and clover, and very probably may become very important to this crop.

Another species of wide extent and distribution in the northeastern part of the United States is *Stictocephala lutea*. This species apparently has a rather general distribution in food habit, being taken from a considerable variety of plants, and so far it seems impossible to assign it to any one as a favorite. It is, however, a quite abundant species, being found in swarms in some instances in very small areas, and in such cases must be a sufficient menace to be worthy of investigation. The range of this species seems to fit fairly well to the distribution of *festina*, being common from Georgia northward through the Northern States to Canada, its southern boundary agreeing in a somewhat general way with the northern boundary of *festina* in the eastern part of its range.

Other species of the genus are found in Southern, Southwestern Pacific States, but so far, they have been observed only in limited and numbers.

While the information about the habits, life histories, etc., of these species is still rather limited, it seems quite desirable that this information should be brought together, that the attention of workers in different parts of the country may be centered upon these as possible serious pests, and definite knowledge acquired so that whatever may be done in the direction of suppression may be adopted in proper season.

PRESIDENT SANDERSON: Is there any discussion of this paper?

Mr. R. L. WEBSTER: I would like to ask Professor Osborn where the eggs are laid.

Mr. OSBORN: We should find them in the tissues of the stems of the plant. I would not want to make a general statement, but there is where we look for them.

Mr. R. L. WEBSTER: I have found them in the woody tissues of the apple. I suspect they might lay their eggs in various places. As I remember, in this case I bred the larvæ on apple and they deposited eggs in the woody tissue.

Mr. OSBORN: I might add that there are some species of *Ceresa* which act in very much the same manner as *Stictocephala*.

PRESIDENT SANDERSON: The next paper on the program is by Professor Washburn on "Methods of Securing the Fertilization of Clover by Means of Bumblebees, in Experiments with *Bruchophagus funebris*."

A METHOD OF SECURING THE FERTILIZATION OF CLOVER BY MEANS OF BUMBLEBEES, IN EXPERIMENTS WITH BRUCHOPHAGUS FUNEBRIS

By F. L. WASHBURN, *St. Anthony Park, Minn.*

At the very beginning of work on the life history of *Bruchophagus* we found it necessary to secure clover seed properly fertilized and yet immune from insect attack. This, as we discovered, was a most difficult thing to accomplish. For two years we tried in vain to do this by hand pollination, the work being begun by Mr. Ruggles, and continued by Doctor Franklin. Naturally, we were discouraged. I am happy to say, however, that this year, by the method described here, we have succeeded in this very essential matter, and have had no trouble in securing fertilized seed, suffering in no way from insect attack, and thus forming a basis for investigations on the life history of the insect in question. As stated above, the work was begun over

two years ago by Mr. Ruggles, later joined by Doctor Franklin. We have recently added to our force, under the provisions of the Adams Act, Mr. Theodore Urbahns, who is, at present, giving his entire time to this problem. Mr. Urbahns has invented a cage which seems to answer the purpose for which it was intended excellently well. This cage is made of a wooden frame, covered with white cheese cloth on three sides and on the top. A loose glass plate forms the fourth side. The floor is of wood, perforated in the center in such a way as to allow clover heads from two or more plants to be introduced into the cage. The cage is suspended over the growing plants. The perforations through which the clover heads are introduced can be shut to exclude other insects, and to keep the clover stems in place, by means of two wooden shutters.

The method of procedure in securing the cross pollination of the florets has been to confine the green heads in other cages, made of mica lamp chimneys closed at the top with a piece of cheese cloth, and at the bottom with a fold of the same kind of cloth, which can be firmly tied around the stem bearing the introduced head. This cage is held in place above a plant by a cord from above and below. This latter apparatus was suggested in an article by C. E. Hood in the April, 1909, number of the JOURNAL OF ECONOMIC ENTOMOLOGY. Of course, these heads might have been covered with cheese-cloth bags, but in that case could not have been so easily watched. When the florets open and are ready for pollination, they are removed from the mica cages and introduced into the cage made by Mr. Urbahns, and described above. Into this cage, one or two bumblebees are introduced, and we found that early in the season the bees worked faithfully every day, after becoming accustomed to their prison, occasionally as long as three weeks. Later in the season their work was not quite so satisfactory, but when captured early in the morning they usually worked well for a few hours, after which time they were liberated. When these clover blossoms have been thoroughly gone over by the bees, they are removed from the pollenizing cage, and again placed in the mica cages for future use in *Bruchophagus* studies.

At the close of this paper Dr. A. F. Woods, dean of the College of Agriculture of the University of Minnesota was introduced by the President.

DEAN WOODS: I do not like to break into this program, but I wanted to come up and see some of the familiar faces, and welcome you to this branch of the university. I think we have a very high

appreciation of entomology here, and have a corner on that subject so far as the university is concerned. This institution opens its arms to you—every door and every place you want to go into is yours.

PRESIDENT SANDERSON: The next paper will be given by Mr. George A. Dean, Manhattan, Kan., on "Fatal High Temperatures for the Control of Mill Insects."

HEAT AS A MEANS OF CONTROLLING MILL INSECTS[1]

By GEORGE A. DEAN, *Manhattan, Kan.*

In connection with investigations relative to the inspection and fumigation of flour mills, the writer noticed on several occasions that the common mill insects were dead, although they were surrounded with an abundance of food. Upon further investigation it was observed that these insects were most frequently found dead in those parts of the mill where, owing to the surrounding conditions, they could easily have been subjected to a temperature varying from 105° to 120° F. for four or five hours per day and for a period of several days.

On looking over available literature relative to the control of this class of insects, it was found that the French long ago knew the value of heat and devised contrivances, called insect mills, for the heating of infested grain. Experiments made by Prof. F. M. Webster in 1883 to ascertain the amount of heat required to destroy the Angoumois grain moth gave these results, "a temperature of 140° F., continued for nine hours, literally cooks the larvæ or pupæ. A temperature of 130° F., for five hours, is fatal, as is also 120° for four hours, while 110° applied for six hours was only partially effective." It was also found in his experiments that wheat could be subjected to a temperature of 150° for eight hours without impairing its germinat-

[1]This paper embodies the results of some of the investigations undertaken by the writer in the prosecution of project No. 58, "Insects Injurious to Stored Grain and Stored Grain Products," of the Kansas State Agricultural Experiment Station.

The writer desires to acknowledge the valuable assistance rendered by Mr. R. M. Caldwell in carrying out laboratory experiments, and by Mr. Caldwell and Mr. F. B. Milliken in fumigating various mills with hydrocyanic acid gas, and in making trials of heat as a method of destroying mill insects in the large mill where the practical tests were made.

ing properties. In the second report of the state entomologist of New York, Prof. J. A. Lintner, in speaking of *Tribolium ferrugineum* infesting grain and flour says, "A moderate degree of heat, 120° to 130° F., continued for a few hours, would in all probability suffice to kill all the eggs, larvæ and pupæ in the material, while a higher temperature, perhaps 150° or more, would be needed for the beetles. Prof. F. H. Chittenden in his article on "Insects Injurious to Stored Grain" says, "Prior to the adoption of carbon disulphide as a fumigant, heat was relied upon in the destruction of these insects. A temperature of from 125° to 140° F., continued for a few hours, is fatal to grain insects, and wheat can be subjected to a temperature of 150° for a short time without destroying its germinating power."

Nearly all the experiments of this nature were made relative to the discovery of a method to destroy Angoumois grain moth, and from the results of these experiments some of the experimenters and other writers have assumed that many of the grain insects could probably be destroyed in the same manner, but it would require a higher temperature to destroy the adults than the larvæ or pupæ. Since this method of combating grain insects was not developed and given a practical test in a flour mill, and believing that the death of these insects in the Kansas mills was caused by a fatal maximum temperature, the next step was to determine this temperature and to ascertain whether it would be possible and practical to not only produce such a condition in a modern mill, but whether it would prove fatal to the insects therein.

In the first experiment about twenty-five individuals of both the adult and larvæ of *Tribolium confusum* were placed in a shell vial and covered with an inch of flour. A thermometer was placed in this vial with the bulb resting in the center of the flour. The vial containing the flour and various stages of *Tribolium confusum* was next suspended in a large bottle in such a manner as not to touch the sides of it. This bottle was then placed in a glass jar filled with water, and this glass jar was placed in a vessel filled with water. The heat was applied beneath this vessel. This arrangement reduced to a minimum the unequal distribution of the heat in the shell vial containing the insects. In raising the temperature from 80° to 90° no change was noticed in the action of these insects. At a temperature of about 96° the adults became uneasy and began running around rather rapidly. At a temperature of 100° the larvæ emerged and crawled over the flour, and the adults were running more rapidly than at 96°. At a temperature of 110° both larvæ and adults were frantic and were making every effort to escape, and these actions were continued until a temperature of 115° was reached. At this temperature both the

larvæ and adults were becoming passive, and at a temperature of 118° all adults were lying on their backs apparently dead, while four or five larvæ showed very feeble movements. At a temperature of 119° there was no sign of life; however, the temperature was raised to 120° and then the insects were removed and given a chance to recover, but none did. This experiment was repeated several times and each time as soon as a temperature of from 119° to 120° was reached it proved fatal to all stages of the insects. It required from twelve to fifteen minutes to reach this fatal temperature.

Similar experiments were conducted and repeated with the larvæ, pupæ, and adults of *Silvanus surinamensis*, *Ephestia kuehniella*, *Tenebrioides mauritanicus*, and the adults of *Calandra oryza*. As soon as a temperature of 116° was reached it proved fatal to the adults of *Ephestia kuehniella* while it required a temperature of 118° to prove fatal to the larvæ and pupæ. A temperature of 118° was fatal to the adults of *Calandra oryza*, and a temperature of 119° proved fatal to all stages of *Silvanus surinamensis*. At a temperature of 120° the majority of the *Tenebrioides mauritanicus* perished, but it required a temperature of 120° for a period of three minutes to prove fatal to all.

In a second series of experiments a paraffin oven or incubator was used, and after the oven was heated to a required temperature, the insects were placed in it and the oven held to a constant temperature throughout the experiment. In this experiment about twenty-five specimens of the eggs, larvæ, pupæ and adults of *Tribolium confusum*, larvæ and pupæ of the *Ephestia kuehniella*, and the adults of *Calandra oryza*, and *Tenebrioides mauritanicus* were used. Experiments were made not only with these various stages of insects on top of the flour, but one and two inches below the surface. After a series of experiments it was found that a temperature of 115° for a period of twelve hours proved fatal to all the insects in their various stages.

Since in practical use it would be impossible to actually heat a mill in a few minutes as in the first series of experiments, or subject them to such a sudden change as in the second series, a third set of experiments was conducted to determine the fatal temperature under conditions that could actually be produced in a mill. In these experiments the larvæ, pupæ, and adults of *Tribolium confusum*, the adults of *Silvanus surinamensis*, and *Ephestia kuehniella* were used. The various stages of the different insects were placed in shell vials, so that their actions under the slowly rising temperature of the oven could be observed. The heat was applied at 8 a. m. and the temperature noted at intervals of every half hour. The temperature at the

Chart Showing Rise of Temperature in Paraffine Oven.

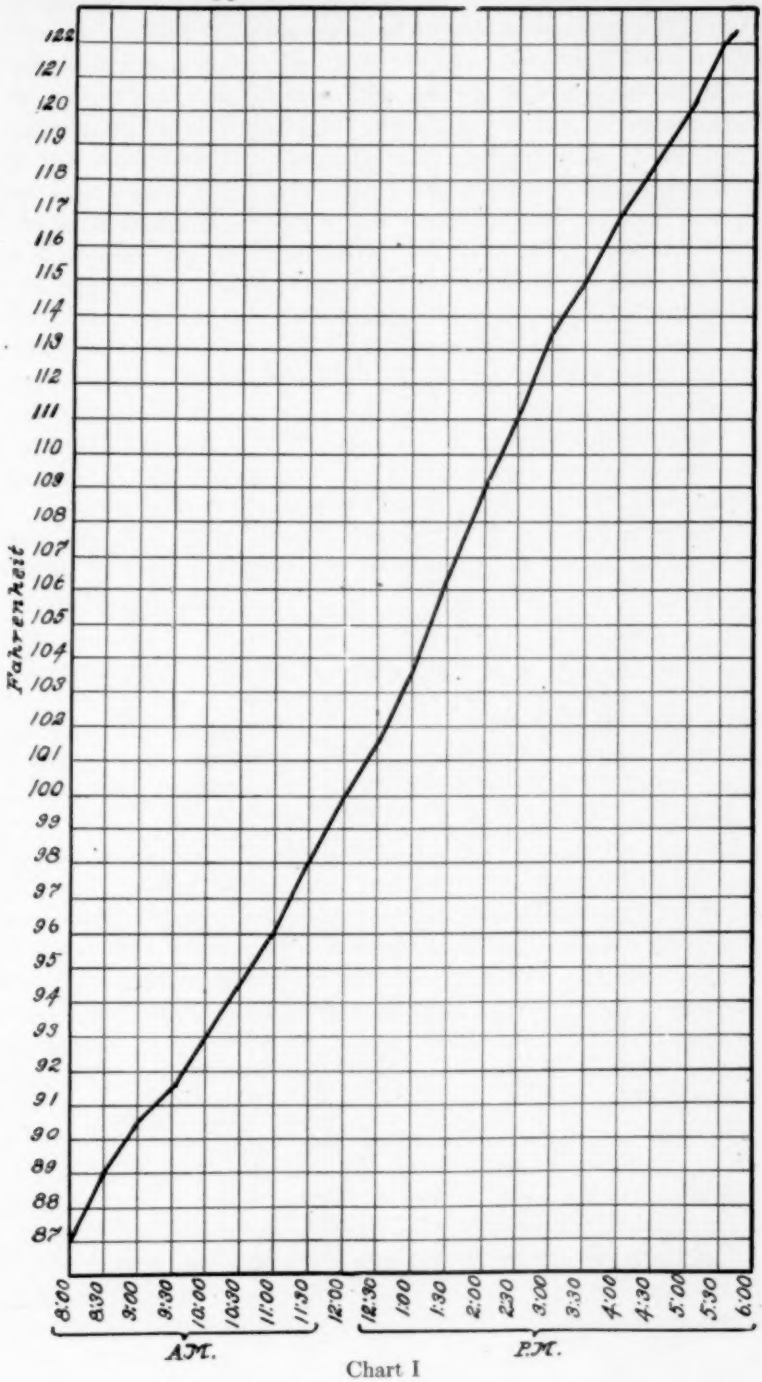


Chart I

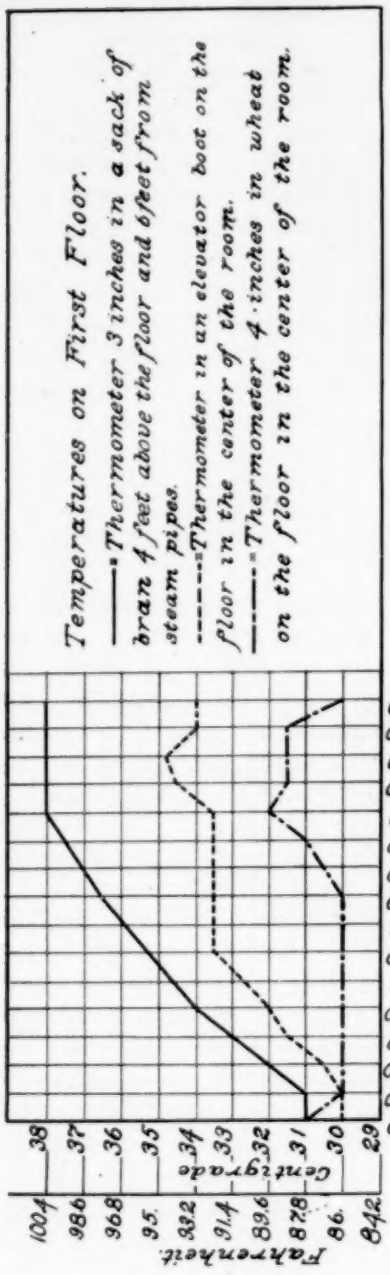

Temperatures on First Floor.
——=Thermometer 3 inches in a sack of bran 4 feet above the floor and 6 feet from steam pipes.
- - - - =Thermometer in an elevator boot on the floor in the center of the room.
——·——=Thermometer 4 inches in wheat on the floor in the center of the room.
Fahrenheit.
Centigrade
100.4
98.6
96.8
95.
93.2
91.4
89.6
87.8
86.
84.2
38
37
36
35
34
33
32
31
30
29
10:00
10:30
11:00
11:30
A.M.
12:00
12:30
1:00
1:30
2:00
2:30
3:00
3:30
4:00
4:30
5:00
5:30
P.M.

Chart II

time the insects were placed in the incubator was 87°, or the same as the temperature of the place from which they were taken. The behavior of the various insects as the temperature gradually increased was most interesting. At 10.45 a. m., with a temperature of 95°, the larvæ and adults of *Tribolium confusum* began to appear uneasy, and their uneasiness increased rapidly with the rise of temperature. At 11.45 a. m. with a temperature of 99°, the adults of *Ephestia kuehniella* began to move and fly about with the same uneasiness. At 2.15 p. m. with a temperature of 110°, all stages of the different insects were most active and were making every effort to escape the heat. Even the pupæ were wriggling and struggling. At 3.45 p. m., with a temperature of 116.5°, the first adult of *Ephestia kuehniella* died, and at 4.30 p. m., with a temperature of 118.5°, all the moths were dead, and a few of the adults and larvæ of *Tribolium confusum*. At 5.15 p. m., with a temperature of 121°, all of the *Silvanus surinamensis* were dead, but two adults and five larvæ of *Tribolium confusum* were alive. At 5.30 p. m., with a temperature of 122°, two larvæ of *Tribolium confusum* were still alive, but these died eleven minutes later at a temperature of 122.5°. In this experiment fifteen insects of each stage were used. (Chart I.)

The Heat Method Put to a Test in a Modern Mill

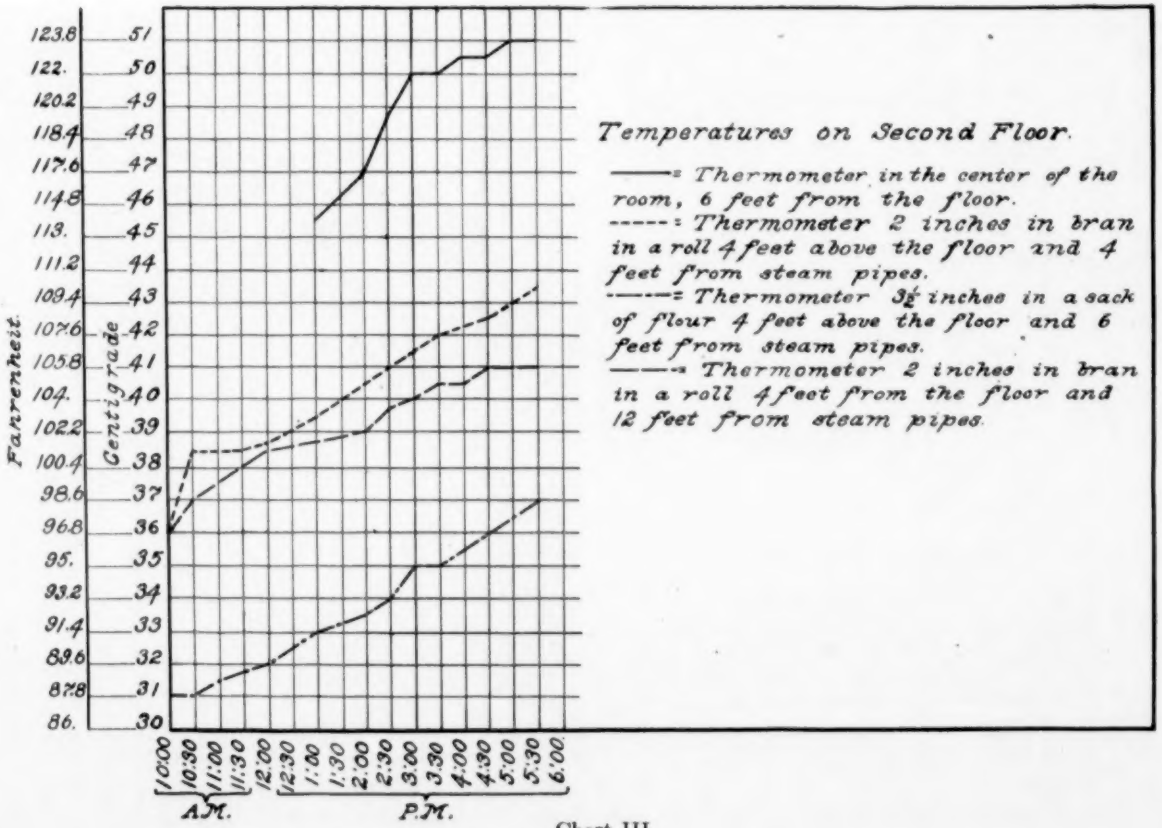
Since the laboratory experiments demonstrated that this class of insects could be destroyed at a temperature not beyond that which could actually be produced within a modern mill, a flour mill was selected for a practical test. This mill had heavy brick walls and tight wooden floors. It had no basement, was four stories high, all stories were heated with steam, and were well filled with machinery. The packers, elevator boots, and pulley machinery were on the first floor; the rolls were on the second floor, and the purifiers, sifters, and bolters were on the third and fourth floors. It had a daily capacity of 600 barrels, and in its construction represented the average modern mill in the state of Kansas. The first floor, 38 feet wide, 63 feet long, and 12 feet high, with a capacity of 28,728 cu. ft., was heated by eight one and one-half-inch steam pipes, the radiating surface of which was 515 sq. ft. These pipes were arranged in eight coils near the ceiling along the two sides and across one end of the room. The pipes were placed near the ceiling in order not to obstruct the doorways. The second floor, the capacity of which was the same as that of the first, had one coil less of the steam pipes with a radiating surface of 450 sq. ft., but these seven coils were placed near the floor along the side walls and across one end. The third floor which was

13 feet high and with a capacity of 31,122 cu. ft. had six coils with a radiating surface of 386 sq. ft., and these were placed the same as those on the second floor. The fourth floor which was 18 feet high and with a capacity of 43,092 cu. ft., had only five coils with a radiating surface of 322 sq. ft. These pipes were arranged like those on the second and third floors.

TABLE SHOWING THE DIMENSIONS AND HEATING SYSTEM OF THE MILL

Floor	Dimensions	Capacity in cu. ft.	No. of coils of steam pipes	Diam. of steam pipes (in.)	Linear feet of steam pipes	Radiating surface of steam pipes (sq. ft.)	Location of steam pipes	Remarks
1	38 x 63 x 12	28,728	8	1½	1,312	514.96	Near ceiling	
2	38 x 63 x 12	28,728	7	1½	1,148	450.59	Near floor	There were no steam pipes across one end of each floor
3	38 x 63 x 13	31,122	6	1½	948	386.22	Near floor	
4	38 x 63 x 18	43,092	5	1½	820	321.85	Near floor	
	Total	131,670	26		4,264	1,673.62		

This mill was badly infested with all stages of *Tribolium confusum*, and slightly infested with several of the other common mill insects. In the first experiment no change of any sort was made in the heating system. Four thermometers were distributed on each floor in such a manner as to get the temperature not only in the open, but in different depths of flour, and in accumulations in different parts of the room. At 10 o'clock a. m., August 21, with the mill just as it had been shut down for Sunday, the steam was turned into the pipes, and since this mill was ordinarily heated with exhaust steam, the live steam had to be forced through the exhaust pipe, which prevented it from having more than two or three pounds pressure. The heat was applied from 10 a. m. to 5.30 p. m., and the temperatures of all the thermometers noted at intervals of every half hour. Although the day was very warm, reaching a maximum temperature of 95°, and the average temperature of the mill before the heat was applied was 89°, yet the mill did not heat rapidly, and by 5 o'clock there were only two or three places in the mill where a fatal temperature had been reached. On the first floor the highest temperature was 100.4°, while one thermometer in the bottom of an elevator boot registered only 94°.


Fahrenheit.
123.8
122.
120.2
118.4
117.6
114.8
113.
111.2
109.4
107.6
105.8
104.
102.2
100.4
98.6
96.8
95.
93.2
91.4
89.6
87.8
86.
Centigrade
51
50
49
48
47
46
45
44
43
42
41
40
39
38
37
36
35
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32
31
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10:00
10:30
11:00
11:30
12:00
12:30
1:00
1:30
2:00
2:30
3:00
3:30
4:00
4:30
5:00
5:30
6:00
A.M.
P.M.
Temperatures on Second Floor.
——= Thermometer in the center of the room, 6 feet from the floor.
-----= Thermometer 2 inches in bran in a roll 4 feet above the floor and 4 feet from steam pipes.
——·——= Thermometer 3½ inches in a sack of flour 4 feet above the floor and 6 feet from steam pipes.
——··——= Thermometer 2 inches in bran in a roll 4 feet from the floor and 12 feet from steam pipes.

Chart III

Temperatures on Third Floor.
——• Thermometer in center of the room and 6 feet above the floor.
- - - - - Thermometer in flour in a conveyor spout 3 feet from the floor.
—·—·— Thermometer 2 inches in middlings in a conveyor spout 4 feet above the floor and 8 feet from steam pipes.
— — — Thermometer in flour in a conveyor 6 feet above the floor and in the center of the room.
Fahrenheit
Centigrade
1236 1238 122. 120.2 118.4 117.6 114.8 113 111.2 109. 107.6 105.8 104. 102.2 100.4 98.6 96.8 95. 93.2 91.4 89.6 87.8 86.
52 51 50 49 48 47 46 45 44 43 42 41 40 39 38 37 36 35 34 33 32 31 30
10:00 10:30 11:00 11:30 12:00 12:30 1:00 1:30 2:00 2:30 3:00 3:30 4:00 4:30 5:00 5:30
A.M.
P.M.

Chart IV

(Chart II.) On the second floor the highest temperature, 123.8°, was registered by the thermometer hanging in the open, while the lowest temperature, 98.6°, was registered by a thermometer three and one-half inches in a sack of flour four feet above the floor. (Chart III.) On the third floor the thermometer in the open registered 125.6°, and the lowest temperature, 114°, was registered in a flour conveyor six feet above the floor. (Chart IV.) On the fourth floor the thermometer in the open registered 118.4°, and the lowest temperature, 107.6°, was registered by the thermometer two inches in flour in a conveyor near the floor. (Chart V.)

A hydrograph was placed on the second floor in the middle of the room. The relative humidity of this floor at 10 a. m., or just as the heat was applied was 93 per cent. From 10 a. m. to 12 m. there was a rapid decrease to 40 per cent, and from 12 m. to 5.30 p. m. there was a gradual decrease to 27 per cent.

Although the temperatures reached were disappointing, and no insects were killed on the first floor, yet on the third floor fully one third of the insects perished, and on the fourth floor about one fourth succumbed to the heat. Even the second floor showed that many insects had perished. The experiment proved the following: More time must be taken to reach the desired temperature; this temperature should be held several hours to allow the heat to penetrate all of the infested parts; there should be a water trap to draw off the water accumulated in the steam pipes; the steam should be turned on with some pressure so as to heat the mill more rapidly; the steam pipes should be near the floor in order to heat the room.

In the second experiment, made three weeks later, two changes were made in the heating system. A water trap was attached and arrangement made to turn the steam on directly and with pressure. The arrangement of the pipes in the mill was not altered. At 6 a. m., September 11, the mill was shut down and, after the thermometers were distributed as in the first experiment, the steam was turned on with ten to twelve pounds pressure. The heat was applied from 6 a. m., until 6 a. m. the day following, and the temperature of the sixteen thermometers noted at intervals of every half hour, save in a few cases when the readings were made at intervals of one hour. The average temperature in the mill at the time the heat was applied was about 90°, and the mean temperature during the day outside of the mill was 77°.

In nearly all parts of the mill the temperatures gradually increased, and at 3 o'clock p. m. fatal temperatures were reached in several parts. At 6 o'clock p. m. many of the insects had perished. At 9 o'clock p. m. fatal temperatures were indicated by nearly all the

thermometers except on the first floor. However, realizing that it required time to heat through heavy machinery and to penetrate into several inches of flour, the heat was continued until 6 a. m., by which time it had penetrated the innermost recesses of the mill, save the first floor. On the first floor the highest temperature was 105°, while one thermometer in four inches of wheat near the floor registered only 96°. (Chart VI.) On the second floor the highest temperature, 133.5°, was registered by a thermometer hanging in the open, while the lowest temperature, 117.6°, was registered by a thermometer three inches in a sack of flour three feet above the floor. (Chart VII.) On the third floor the thermometer in the open registered 141°, and the lowest temperature, 129°, was registered in a flour conveyor spout four feet above the floor. (Chart VIII.) On the fourth floor the thermometer in the open registered 128.6°, and the lowest temperature, 118°, was registered by a thermometer in flour in a conveyor six feet above the floor. (Chart IX.)

The hydrograph was placed on the second floor in the middle of the room. The relative humidity of this floor at 6 a. m., or just as the heat was applied, was about 72 per cent. During the first few hours there was a rapid decrease to less than 40 per cent, and during the afternoon and through the entire night there was a very gradual decrease to 12 per cent.

After a very careful examination of the three upper floors, all parts of the mill, even the deepest accumulations in the most inaccessible parts, failed to show live insects, save in one corner on the upper floor. In several places where there were accumulations inaccessible to hydrocyanic acid gas, the conveyor or the bins were torn open, and after being carefully inspected, did not reveal a live insect, but showed that thousands had perished. In a sample room on the third floor there were hundreds of samples of grain in paper and cloth bags, tin cans, and sealed glass jars. These were badly infested; but all of the insects were killed by the heat. On the fourth floor there was a large flour conveyor running the entire length of the mill, and in this conveyor the accumulation of flour which was from three to five inches in depth was badly infested, but, after tearing it open from one end almost to the other, it was found that all of the insects had perished. Nearly three weeks later a second examination was made of the mill and no live insects of any sort were found above the first story.

In a mill, flour accumulates in recesses, and insects breed in places inaccessible to the gas or vapor of any fumigating material, but heat passes through all of these obstructions and penetrates the innermost recesses. The writer has fumigated many mills with hydrocyanic acid gas, but in no case has the fumigation proved so successful as

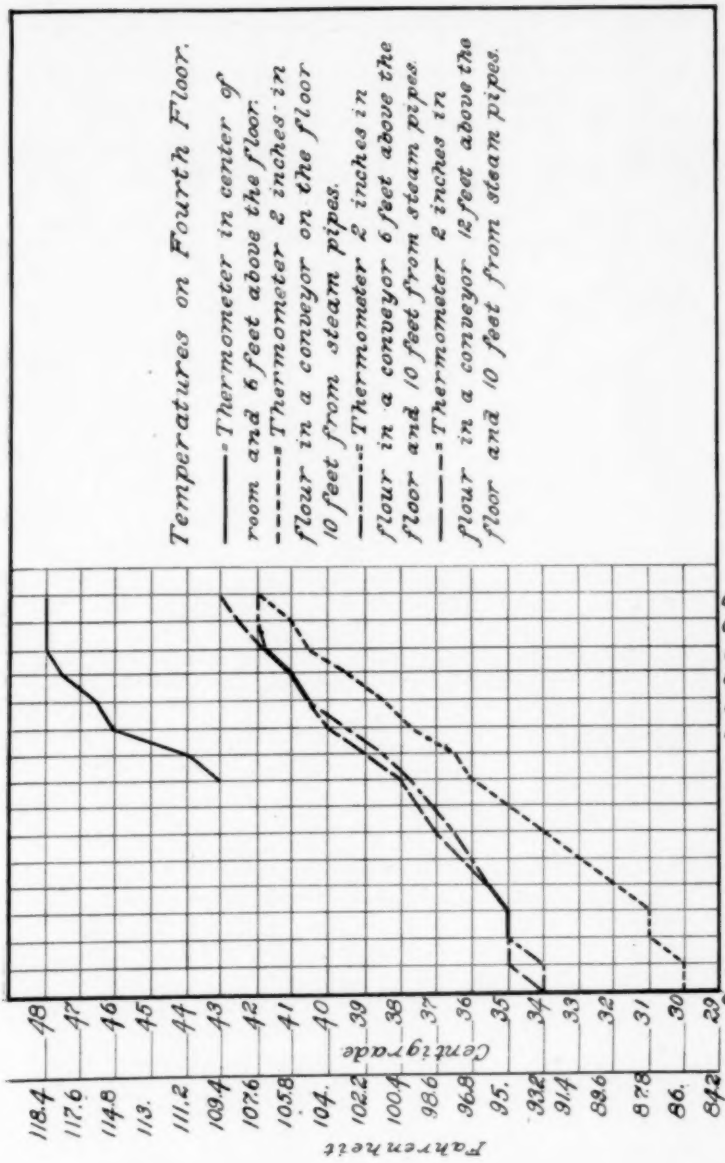

Temperatures on Fourth Floor.
——=Thermometer in center of room and 6 feet above the floor.
- - - - - =Thermometer 2 inches in flour in a conveyor on the floor 10 feet from steam pipes.
—·—·— =Thermometer 2 inches in flour in a conveyor 6 feet above the floor and 10 feet from steam pipes.
— — — =Thermometer 2 inches in flour in a conveyor 12 feet above the floor and 10 feet from steam pipes.
Fahrenheit
Centigrade
A.M.
P.M.
10:00 10:30 11:00 11:30 12:00 12:30 1:00 1:30 2:00 2:30 3:00 3:30 4:00 4:30 5:00 5:30
118.4 117.6 114.8 113. 111.2 109.4 107.6 105.8 104. 102.2 100.4 98.6 96.8 95. 93.2 91.4 89.6 87.8 86. 84.2
48 47 46 45 44 43 42 41 40 39 38 37 36 35 34 33 32 31 30 29

Chart V

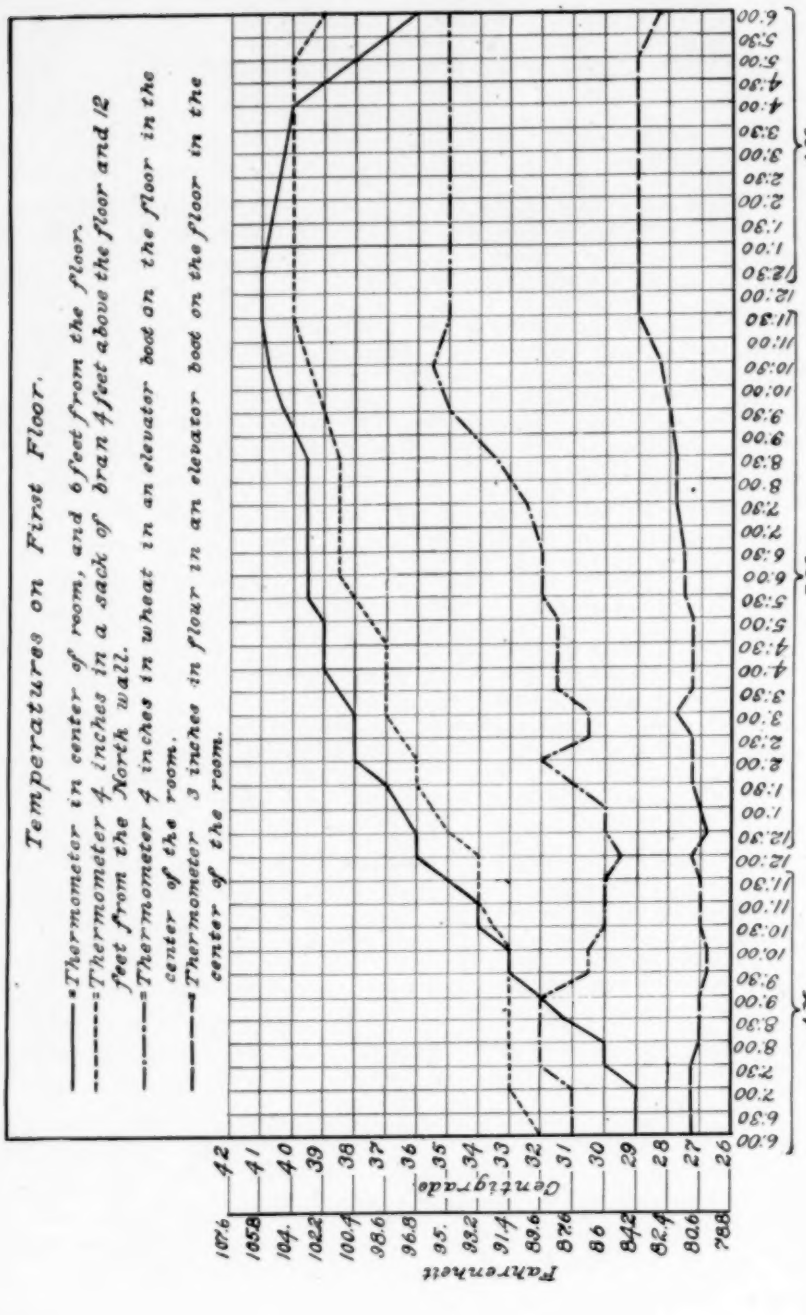

Temperatures on First Floor.
Thermometer in center of room, and 6 feet from the floor.
Thermometer 4 inches in a sack of bran 4 feet above the floor and 12 feet from the North wall.
Thermometer 4 inches in wheat in an elevator boot on the floor in the center of the room.
Thermometer 3 inches in flour in an elevator boot on the floor in the center of the room.
Fahrenheit
Centigrade
A.M.
P.M.
A.M.

Chart VI

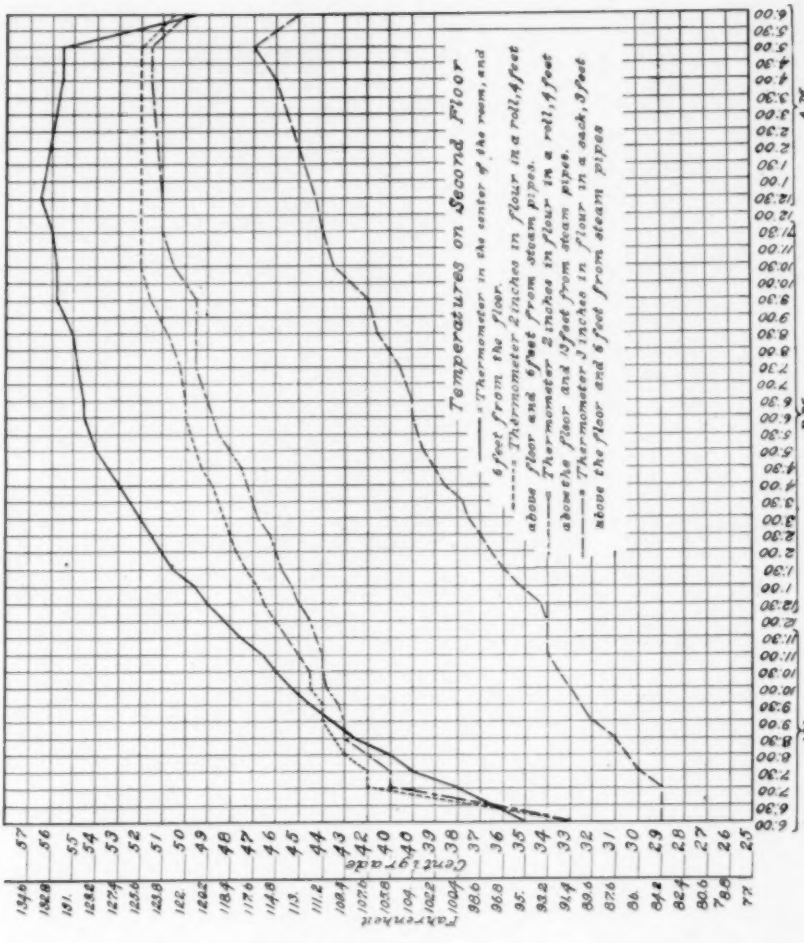

Temperatures on Second Floor
Thermometer in the center of the room, and 6 feet from the floor.
Thermometer 2 inches in floor in a roll, 4 feet above floor and 6 feet from steam pipes.
Thermometer 2 inches in floor in a roll, 4 feet above the floor and 3 feet from steam pipes.
Thermometer 3 inches in floor in a sack, 3 feet above the floor and 6 feet from steam pipes
Fahrenheit
Centigrade
A.M.
P.M.

Chart VII

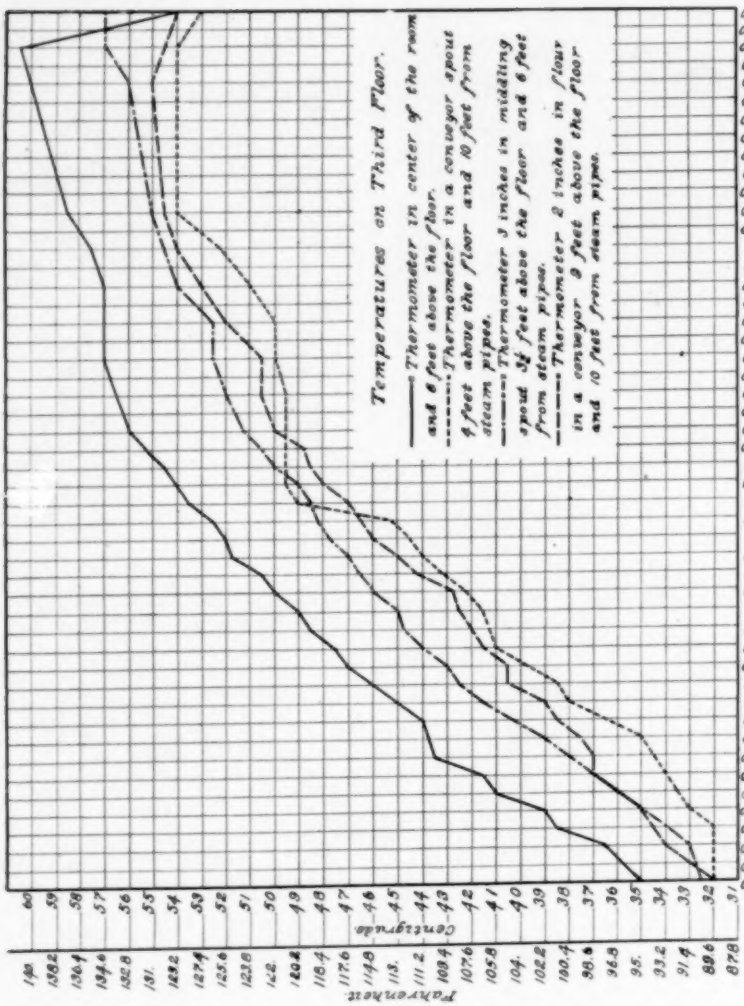

Temperatures on Third Floor.
Thermometer in center of the room and 6 feet above the floor.
Thermometer in a conveyor spout 9 feet above the floor and 10 feet from steam pipes.
Thermometer 3 inches in midding spout 9½ feet above the floor and 6 feet from steam pipes.
Thermometer 2 inches in floor in a conveyor 8 feet above the floor and 10 feet from steam pipes.
Fahrenheit.
Centigrade.
A.M.
P.M.
A.M.

Chart VIII

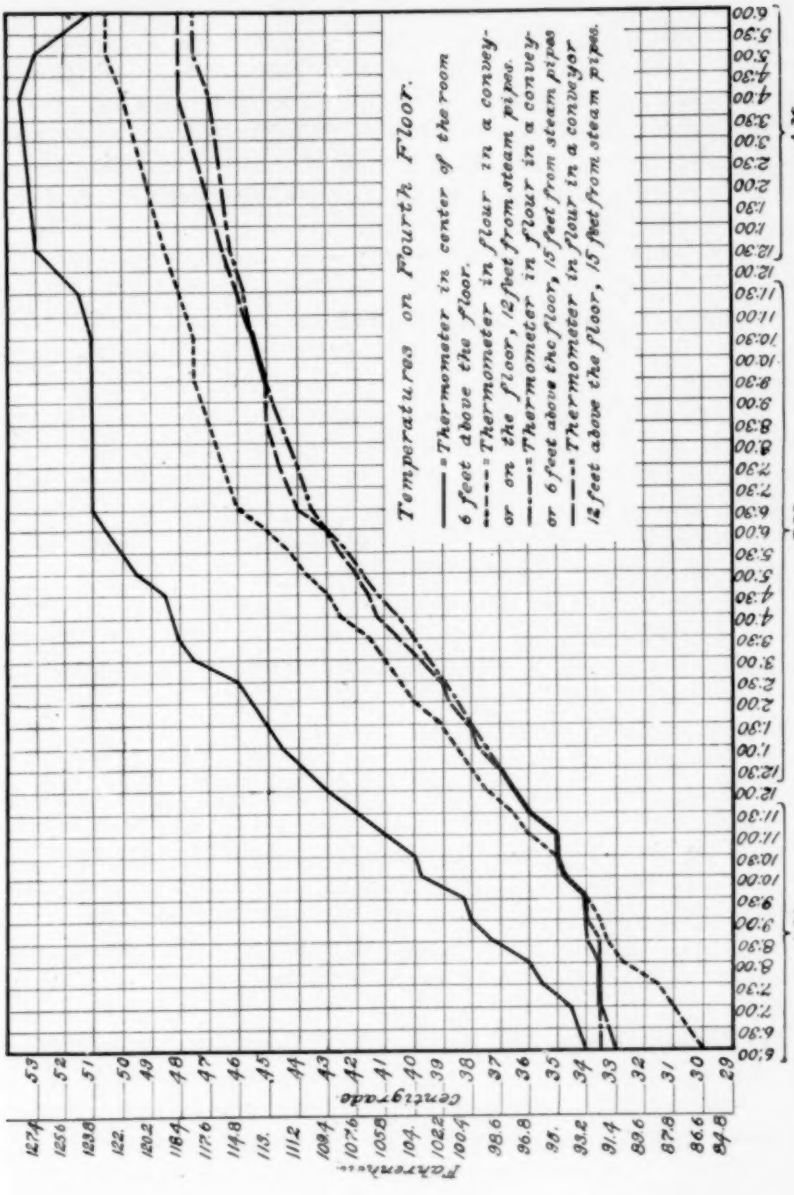

Temperatures on Fourth Floor.
——= Thermometer in center of the room 6 feet above the floor.
– – – = Thermometer in flour in a conveyor on the floor, 12 feet from steam pipes.
—·—·— = Thermometer in flour in a conveyor 6 feet above the floor, 15 feet from steam pipes
——·— = Thermometer in flour in a conveyor 12 feet above the floor, 15 feet from steam pipes.
Fahrenheit
Centigrade
A.M.
P.M.
A.M.

Chart IX

the heating of this mill, and in this case with a few alterations in the arrangement of the steam pipes, and with some additional radiating surface, this would be the most efficient, convenient, and least expensive method. To fumigate with hydrocyanic acid gas, requires from two to three days, and this long shut-down, with the additional cost of material, is a large item of expense besides being dangerous to the life of the operator, while with the heat, since it can be applied from Sunday morning until Monday morning, there is no loss of time, very little expense, and no danger to the life of the operator.

PRESIDENT SANDERSON: Any discussion?

MR. WASHBURN: You do not mention anything about the eggs of *Ephestia*.

MR. DEAN: This mill was not infested with the Mediterranean flour moth.

MR. WASHBURN: But you do not know whether you can free a mill of eggs by this method.

MR. DEAN: Since this mill showed no live insects three weeks later, I believe all eggs were killed in the upper stories.

MR. WASHBURN: Then there are enough eggs in the lower story to restock the entire mill.

MR. DEAN: The point is this, Professor Washburn, if those pipes had gone down to the lower floor we could have had as high temperatures there as on the upper floors.

MR. WASHBURN: Have you tried it in the winter time in Kansas?

MR. DEAN: No. In the second experiment the temperature was 77° outside.

MR. WASHBURN: My point is this, with the method of piping in a mill, that in the winter it would be hard to get the temperatures required in the lower stories.

MR. DEAN: All the mills would have to put in more radiation, but that would cost less than shutting down for fumigation two or three days.

MR. WASHBURN: In fumigating with hydrocyanic acid gas they only shut down from Saturday night to Sunday morning. They do it when they are cleaning the mill, and part of the cleaning process with many millers is fumigating with hydrocyanic acid gas.

A MEMBER: I find that the employees in mills undertake fumigation with hesitancy.

MR. DEAN: I have heard men state that they would quit the job before they would touch it. In the case of fumigation the mill has

to be cleaned out, and prepared for fumigation, but with this other method it is not necessary to clean out the accumulations and some millers state that they would rather spend $2,000 or $3,000 for heating apparatus than to spend $500 or $600 every year for fumigation.

MR. WASHBURN: It seems to me that this is a most excellent paper. At the same time I do not see how they estimate the expense of fumigating at such a high figure because the material is not very expensive.

MR. DEAN: When you use 1,500 pounds of cyanide the material counts up, to say nothing of the two or three days shut down.

MR. WASHBURN: In Canada in a very large mill, we used a ton of material, but even that expense would have been trebled if they had to pipe the mill. Of course, if you can reach *Tribolium* buried two, or three, or four inches in flour, you have done a good work. The gas would not go through a sack of bran.

MR. DEAN: They removed a large roll and the insects were killed in the accumulation back of the machinery which was two inches thick.

MR. WASHBURN: Some millers have a wrong idea as to hydrocyanic acid gas. I have run to earth four or five stories of men killed by accident. One or two men have been killed by bisulfid of carbon, but I have yet to find a single individual killed by hydrocyanic acid gas. Several men, to my knowledge, use this once or twice a year, when they clean, but they never successfully reach *Tribolium*, that insect is so insidious, and if heat will do it, it is a good thing.

MR. HEADLEE: I cannot forbear raising the question as to whether, if the mills are tight and properly heated during the summer season, and all the insects killed, there would be any necessity for heating during the winter.

MR. LOWE: The point which interested me particularly in this paper presented by Mr. Dean, is the fact that the insects were killed in the sealed container. I have a mill and big seed store placed at my disposal, and I have been experimenting with a new product which we have, but have not obtained any good results, particularly in the spouts, and in the inaccessible parts, but I shall now test the idea Mr. Dean has brought out and hope by our next meeting to bring some corroborative results.

MR. WASHBURN: I would like to ask Mr. Dean if this method will kill the eggs.

MR. DEAN: In the experiments in the laboratory where it required from 8 in the morning until 5 o'clock in the afternoon to reach the high temperature, we had eggs and larvæ, and the eggs perished before the larvæ. Eggs subjected to a temperature of 120° for fifteen minutes were killed. It takes a longer time to penetrate mill products.

MR. WASHBURN: I was thinking of the spouts, elevators, etc.

MR. DEAN: If the egg is subjected to a temperature of 120° it perishes in a short time.

MR. WASHBURN: No injury to mill products?

MR. DEAN: None.

MR. LOWE: Do the insects leave the flour when they are about to die?

MR. DEAN: I will say this, I saw a great many dead insects on the floor. They became uncomfortable and rushed out into the hot air. They did not get far and never reached the window and many times did not go four or five inches.

MR. SMITH: This promises to be a very beneficial and useful method, and it occurs to me that in large stores which frequently have insect pests, if this method was available it would be a blessing, especially to tobacco factories and the like. I should like to ask Mr. Dean if he has made any experiments outside of mills, and on other insects.

MR. DEAN: The experiment was tried only on the five mill insects stated in the paper. Of course, these experiments are going to be continued.

MR. SANBORN: I would like to ask Mr. Dean if he thinks this method might not be of considerable importance in the treatment of nursery stock for San José scale.

MR. DEAN: I can say nothing definite on this phase of the subject, but simply make the assumption that I cannot believe any insect is going to stand very much heat.

MR. SHAFER: I think the last statement by Mr. Dean is very true. In histology one of the very best methods of fixing insects is by heat. You can fix the parts of an insect quicker by heat, perhaps, than by any other method that has yet been found. If you go above 150° you get the tissues fixed all the way through and if you do that, of course, you kill the insect. Another point, in regard to the penetration of hydrocyanic acid gas: In the work we had to do with that gas we had a little thing come up, which shows why the gas does not penetrate. I took the percentage of gas in a certain amount of air at the beginning of the experiment, and at the end and found the last precentage of the gas very low. It would fall very rapidly, and if I had 77 per cent in a half hour it might fall to 5 per cent, that is the gas was reducing rapidly—the higher precentage of gas the more rapidly it would fall. Now, if you had some substance like flour which contains moisture, it would be taken up by that moisture, and I think these two reasons would account for the fact that the gas does not penetrate. In the case of carbon bisulfid my experience has been that it does not reduce at all, and I believe, if given time, it would go through.

MR. SMITH: I think that every person who has been West knows that there are some spots on the Pacific coast where it is so hot that it actually bakes the scales on the trees.

MR. SANDERS: I would like to ask Mr. Dean if he has had any objection from millers in respect to danger from fire.

MR. DEAN: I will state that where this experiment was conducted there was one of the most intelligent millers I ever met, and it was his opinion that you could go up to 150° or 160° without danger. No oil waste should be left in the mill. You do not have to go up to a temperature of 150°,—130° is plenty high enough.

MR. WASHBURN: You would have to convince the insurance company, probably, that there was no danger. They refuse to allow the use of carbon bisulfid, and I suppose they would possibly object to heat.

MR. DEAN: As you say, there is a chance for an objection there, but we can easily prove what the combustion point is. Carbon bisulfid is out of the question in a mill. It does not go up where the flour moth is. With hydrocyanic acid gas in the laboratory we killed the eggs in three inches of flour by subjecting them to the same strength as in the mill, but at three and a half inches some escaped. The larvæ of Tribolium perished at four inches.

PRESIDENT SANDERSON: I should like to ask Mr. Dean if he has looked into the matter as to whether these insects exist in the mills in southern Arizona.

MR. DEAN: I have not investigated that at all, but I do not know of any mills in Arizona.

PRESIDENT SANDERSON: I am sure we have all been intensely interested in this paper. It is particularly so to me, and I am sure that if heat will destroy these insects, it will destroy others. We will now have a paper by Mr. S. J. Hunter.

THE GRIESA RESEARCH FELLOWSHIP IN ENTOMOLOGY AT THE UNIVERSITY OF KANSAS

An Announcement by S. J. HUNTER

Mr. W. S. Griesa, proprietor of Mt. Hope Nurseries, Lawrence, Kan., has established the Griesa Research Fellowship in Entomology in memory of his father, the late A. C. Griesa. In establishing this fellowship it was the wish of the founder that the holder should devote himself to a fundamental investigation of one of the several entomological problems ever present with nurserymen.

Upon consultation, it was decided to select for the theme of this research the Woolly Aphis. Mr. H. W. Lohrenz, A. B., McPherson College, and a graduate student at the University of Kansas, was elected by the regents of the university to this fellowship.

The purpose of this research is, after careful experimentation in remedy and prevention, and investigation into the life cycle of this Aphis, to devise a practical means whereby nurserymen can properly deal with this economic problem in such a way as to eliminate the losses now attending the existence of this insect on nursery stock.

The Fellow assumed this work June 15th last, too late to take up the consideration of subterranean stages. In the following preliminary account, therefore, he deals only with the first series of experiments on summer conditions.

It is worthy of note as showing the interest of nurserymen generally in foundations of this nature that the Western Nurserymen's Association, an organization of nurserymen of the Middle Western States, passed resolutions commending the founder of this fellowship for the work he has instituted.

THE WOOLLY APHIS, SCHIZONEURA LANIGERA

By H. W. Lohrenz, *Griesa Research Fellow, University of Kansas*

Field Experiments

First Series

On July 25 twelve plats were marked off with stakes on a block of apple seedlings. All of these were infested with Aphis. The next day, July 25th, these were sprayed, with the exception of plat No. 10. The solution used was a 15 per cent kerosene emulsion. A few inches of soil was removed, and the bases of the trees and the ground about them was thoroughly moistened.

On August 4 plats Nos. 1, 2, 3, 5, 6, 8, 9, 10, and 11 were examined, plats Nos. 4, 7, and 12 were not examined. One live Aphis was found on a root in plat No. 9. In plat No. 10, which had not been sprayed, the Aphis were present in great numbers. The trees in the sprayed plats seemed to be unaffected by the spray and looked as healthy as any in the block.

Plat No. 12 was examined on September 10. One of the sprayed trees showed a few Aphis on the stem about four inches above the ground and on the roots. It should be noted that the tops had not been

sprayed. Just next to the sprayed plat there was a seedling with a large colony of the Aphis. The whole plat, including this infested tree, was sprayed again with a 10 per cent emulsion.

About the 20th of October these seedlings were taken up and examined. The results are given below in tabulated form:

Second Series

On August 10 another series of plats was marked off on the same block of apple seedlings, with the numbers 13–27, Nos. 28 and 29 were added later. The ground was too wet for successful spraying, and because of continuous rains further work had to be postponed until fairer weather set in.

As copper sulphate was recommended by some for insects affecting roots it was tried on plats Nos. 24–27, but without results.

On September 10, although the ground was yet quite wet, a 10 per cent kerosene emulsion was used on plats Nos. 13–16, 21 and 22. The Aphis were present in great abundance, both on the tops and on the roots.

Examination on September 24 and October 1 showed that the 10 per cent emulsion under those conditions had only a limited effect on the Aphis.

On October 1 the ground was in fair condition and plats Nos. 14, 15, 21, and 23 were sprayed again with the 10 per cent emulsion.

About the 20th of October these seedlings were lifted and examined; the results are shown below in tabulated form.

Third Series

Plats Nos. 16, 18, 19, 20, 28, and 29 were used in the third series.

The solution used was kerosene emulsion of 15 per cent strength and was applied October 1.

These seedlings were lifted along with the others about October 20, and the results are tabulated below.

All of the above plats, Nos. 1–29, contained only those places which were very badly infested with Aphis. They extended from six inches to five feet along the rows of the seedlings.

TABULATED RESULTS OF SPRAYING WITH KEROSENE EMULSION

First Series

Sprayed with 15 Per Cent Emulsion on July 26th

Number of plat	Per cent of trees infested before spraying	Number seedlings sprayed	Number seedlings free from Aphis	Number infested at present	Number showing knotty effects
1	90	24	24	0	1
2	90	29	28	1	9
4	85	15	15	0	2
5	85	16	16	0	1
7	85	10	10	0	0
8	85	16	16	0	1
9	90	16	12	4	5
11	85	16	15	1	3
12[1]	90	19	18	1	6
Total		161	154	7	28

Second Series

Sprayed with 10 Per Cent Emulsion on September 10 and October 1

Number of plat	Per cent of trees infested before spraying	Number seedlings sprayed	Number seedlings free from Aphis	Number infested at present	Number showing knotty effects
13[2]	70	18	18	0	1
14	90	6	6	0	1
15	90	36	33	3	13
21	90	28	27	1	4
22[3]	90	10	6	4	2
23[4]	90	20	15	5	8
Total		118	105	13	29

[1]No. 12 was given a second spraying with 10 % emulsion on September 10.
[2]Sprayed only September 10.
[3]Sprayed only September 10.
[4]Sprayed only October 1.

Third Series

Sprayed with 15 Per Cent Emulsion on October 1

Number of plat	Per cent of trees infested before spraying	Number seedlings sprayed	Number seedlings free from Aphis	Number infested at present	Number showing knotty effects
16[1]	90	53	51	2	15
18	90	17	17	0	5
19	90	30	24	6	13
20	90	23	20	3	4
28	90	15	14	1	4
29	90	29	24	5	18
Total		167	150	17	59

Deductions from Above Figures

The first spraying was the most effective. This was due to the fact that the ground was drier, so that the emulsion could soak down to the roots more easily than in the succeeding experiments. Of the total number of trees sprayed, only 87 per cent, or 140 trees were infested. Of these seven showed some Aphis more than two months after the spraying, making 5 per cent infested and 95 per cent freed from Aphis, 20 per cent had become knotty, leaving 80 per cent of the infested stock in good condition for grafting.

Of the trees in the second and third series it must be remarked that at the time of the last spraying, those in the third series were more infested (*i. e.*, each infested tree had a larger number of Aphis) than those in series 2. This difference was due to the fact that the plats in series 2 were sprayed twice, the first time being three weeks before the last spraying.

For the second series, where a 10 per cent emulsion was applied first on September 10 and again on October 1, our figures give a total of 103 infested trees, of which 87.4 per cent were freed from Aphis, leaving 12.6 per cent infested after the spraying; 28 per cent of the infested trees were worthless because of the knotty condition of their roots, leaving 72 per cent to be used for grafting.

Of the 167 trees sprayed with 15 per cent emulsion on October 1 fully 90 per cent, or 150 trees, were at that time infested. Fully 133

[1]No. 16 had been sprayed with the 10 per cent emulsion on September 10, but without any noticeable effects.

No. 17 was a plat not sprayed at all. It contained twenty-two trees; of these, five were free from Aphis, seventeen were infested and seventeen were knotty.

of these, or 88.7 per cent, were freed from Aphis, leaving 11.3 per cent infested. Fully 39.3 per cent were knotty, and only 60.7 per cent could be used for grafting.

The relative value of these three series of experiments can be shown best by the following table:

SUMMARY OF EXPERIMENTS

Number of series	Date of spraying	Strength of emulsion	Per cent of infested trees freed from Aphis	Per cent of trees remaining infested	Per cent of knotty trees	Per cent of trees saved for grafting
1	July 26	15%	95	5	20	80
2	Sept. 10 and Oct. 1	10	87.4	12.6	28	72
3	Oct. 1	15	88.7	11.3	39.3	60.7

A word should be said at this place about the effect of the kerosene emulsion on the roots. None of the seedlings were killed, and the tops showed no ill effects. On examining the roots, however, it was evident that the late spraying had killed a large number of the smaller rootlets and root hairs. These effects were not noticeable on the trees sprayed July 26.

Observations on two-year-old Nursery Stock

The two-year-old apple trees in the nurseries which were examined this summer contained from 20 per cent to 25 per cent infested trees, and several means were tried to free them from Aphis, or at least to prevent further spreading. In one of the nurseries containing about thirty thousand trees kerosene emulsion of 15 per cent strength was applied in a spray. Wherever the spraying was done properly it was quite effective, but no definite figures can be given at this time since the detailed examination will be made in the spring.

At another nursery containing about forty-five thousand trees, the trees had been dust rubbed. When they were taken up in the fall, about 3 per cent were thrown away as worthless because of the effects from Aphis. Of the 318 trees examined in this packing house, thirty-eight were found to have some Aphis. Taking this as a basis, 12 per cent of the stock taken in was infested. Adding to this the 3 per cent thrown away in the field, the infestation in fall has amounted to 15 per cent.

At a third nursery containing about three hundred thousand trees, the trees were rubbed with kerosene emulsion. About 2 per cent

were thrown out in the field. Of 650 trees examined in the packing house sixty were found with Aphis. This gives 9,2 per cent infested, making a total of 11.2 per cent.

NOTES ON FIELD OBSERVATION

About the middle of June the Woolly Aphis was very numerous. In some places from 20–25 per cent of the nursery stock was infested. They were also very numerous on orchard trees of every age. About the end of June the weather grew very warm and dry. As a result the Aphis disappeared, not only the Woolly Aphis of the apple, but many other kinds which had hitherto been very numerous. Very close search on older trees revealed a few on the shady sides under the bark surrounding the scars. It is my opinion that many of the Aphis on the smaller trees and on the nursery stock descend down to the roots at the approach of the summer's heat. Later in the season, as the temperature fell again, the Aphis increased in numbers, and in September there were large colonies. These lasted until the cold weather set in.

Some of the infested nursery stock was sprayed with 15 per cent kerosene emulsion. This killed the Aphis wherever they came in contact with the emulsion, but it is almost impossible to get the emulsion into all the crevices, which are the favored places of the Aphis. Wherever the spraying was done properly the emulsion did not injure the trees, but where too much was put on, it killed the foliage.

Several natural enemies were found to attack the Aphis. One of the parasitic chalcis-flies killed off large colonies in the spring, and for a while it was almost impossible to rear the Aphis in the laboratory, because the parasite had been introduced with stock from the nurseries. This enemy (*Aphelinus mali* Haldeman) was not found in summer and in fall.

In the spring there was also one of the lacewing-flies quite prevalent, the larvæ of which lived on the Woolly Aphis. The larvæ of a syrphus fly was busy not only in the spring, but also in the fall.

NOTES FROM THE LABORATORY

The Woolly Aphis of the apple has no great tendency to wander about and seek new feeding grounds. This seems to be true especially in the spring. At that time I had many apple twigs with Aphis colonies, and in nearly every case the latter perished on the drying twigs. Observations during the month of November show that they are a little more apt to wander in the fall.

Rubbing the trees is a very good method of destroying the Aphis on the tops, especially when care is taken to get into all the crevices. Observation in the laboratory shows that Aphis which are removed while they have their beak in the wood, perish because the beak is broken in most cases. And in no instance did any Aphis so removed establish itself upon the plant again and live.

It takes the young about ten days to come to maturity, during which time it molts four times. In the months of August and September an adult brings forth from two to three young, but the rate of increase seems to be greater in the spring.

The first winged forms were noticed in the laboratory on September 19. During October and the first part of November large numbers of winged forms appeared. On December 6 the last winged form appeared in the laboratory. The winged forms do not produce any woolly secretion. Not every colony in the laboratory produced winged forms. Several colonies were observed where nearly all of the forms produced wings and after the death of the old apterous forms only a few wingless young remained to perpetuate the colony. In some colonies, on the other hand, only a few winged forms were produced.

The offspring of these winged forms are the true sex forms. A number of these winged Aphis were isolated, each one being placed in a separate tube. It was found that they begin to reproduce on the sixth day. This gives the date for the appearance in the laboratory of the first sex forms as September 25. Many of them died without producing any young. Out of a series of nineteen only eleven reproduced, as is shown by the table on page 169.

These true sex forms differ from the agamic forms in that they produce no woolly secretion and have no beak. This latter difference is apparent from the very first, because the young of the common forms have a beak longer than their body. Since these true sex forms have no mouth-parts they cannot take any food, yet they pass through four molts, which seems to require about eighteen days. The male increases very little in size, and increase in the female is probably due mainly to the development of the egg. It may be added here that both sexes remain wingless throughout life.

The sex forms differ among themselves in size and color. From the very first the male is smaller than the female, and in the adult form is not much more than one third the size of the latter. The male is throughout life of an olive green color, while the female retains the light chocolate brown.

Both sexes are quite active in the early part of their life, but apparently they seek only a favorable hiding place, where they can remain

quite inactive. After passing through the last molt, the male becomes quite lively and runs about in search of females, which do not move about in the latter part of their life, but are fertilized and lay their egg at the place where they spend the greater part of their life.

DATA FROM ISOLATED APHIDS

	Number of young produced	Males	Females
1	0	..	..
2	1	1	..
3	4	3	1
4	4	3	1
5	1	1	..
6	2	1	1
7	0	..	..
8	4	2	2
9	1	1	..
10	0	..	..
11	0	..	..
12	3	3	..
13	0	..	..
14	0	..	..
15	3	2	1
6	1	1	..
17	3	3	..
18	0	..	..
19	0	..	..
Totals	27	21	6

Two true sex forms, male and female, which were produced on November 26, had molted for the fourth time on December 8, probably before that time. They were confined to close quarters in a test tube, and after a few hours were seen to mate. On the following day, December 9, the female deposited her egg. The egg is of brown color, and about twice as long as wide. After oviposition the female looked quite shriveled up, yet lived several hours. The mating of this pair had probably not been successful, since the egg retained its brown color.

As seen from the above table, I did not succeed in getting more than four young from a winged female. Other investigators say, however,

that each winged Aphis normally produces eight young, of which four are males and four females, but in their laboratories they succeeded in getting only three to six.

The cytological studies of von Baehr, Volume III, 1909, in the "Archiv für Zellforschung" under the title of "Die Oogenese bei einigen viviparen Aphididen und die Spermatogenese von Aphis saliceti, mit besonderer Berücksichtigung der Chromatinverhaeltnisse," contain valuable facts on the development of true sex forms in *Schizoneura lanigera*. The more important points of that part of his paper bearing on our problem are here given.

Von Baehr removed the embryos from very young nymphs. The nymphs were just showing the wing pads, and the embryos removed from them were, therefore, of the kind regularly developing into true sex forms. Sections of the ovaries of these embryos of true females were compared with sections of ovaries taken from agamic embryos in the same stage of development. At this stage the ovaries of the two forms were exactly alike.

In embryos taken from somewhat older nymphs he found that most of the ovarian tubes contained parthenogenetic eggs, while two of them develop into winter ovaries. Of these two, only one is fully developed, the other ovary with its egg is spoiled before maturity. This explains the process by which only one egg is produced by the true female, whereas all the other forms give birth to more than one young.

MR. SYMONS: I would like to ask Mr. Hunter what was the per cent of Aphids at the beginning of the season?

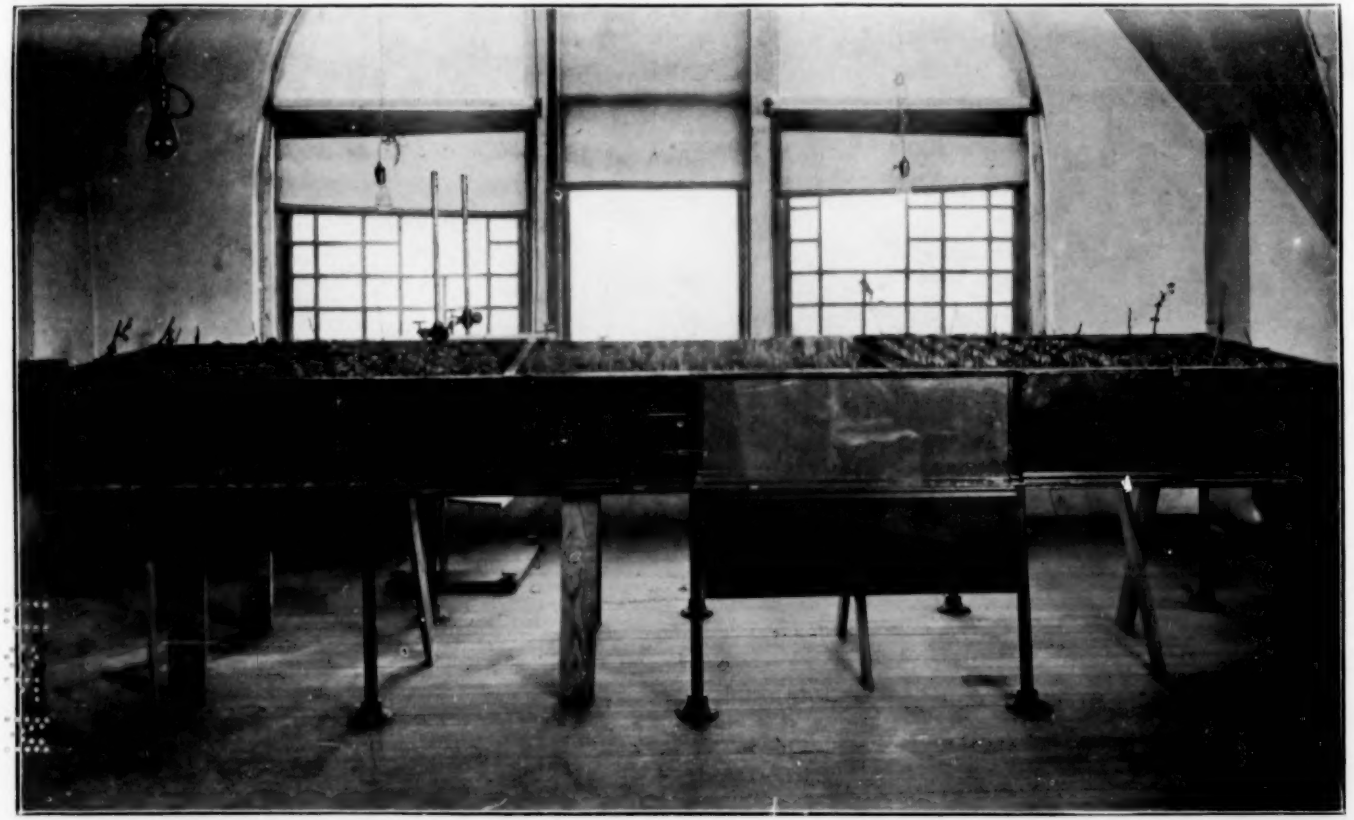
MR. HUNTER: About 90 per cent. We cleared a total of 70 per cent clean trees, about 20 per cent with knotty rootlets and about 10 per cent that had Woolly Aphis present on them after the season's treatment.

MR. SYMONS: You had different blocks?

MR. HUNTER: Of two-year stock.

MR. SYMONS: I tried tobacco dust and lime-sulfur on some two-year-old trees and got the best results with tobacco dust. It was put on very carefully.

PRESIDENT SANDERSON: The next paper will be presented by Mr. A. G. Ruggles.



Apparatus for study of woolly aphis and other subterranean forms: Iron table, 3 x 12 x 1. Iron doors drop, revealing root growths and insects thereon through the glass. That is the earth is held in position by plate glass and kept darkened unless when opened for observation by ten 1 x 3 feet iron doors. (Original.)

THE LARCH SAWFLY IN MINNESOTA

By A. G. Ruggles

The northern part of Minnesota has an enormous acreage in timber, and will have for a number of years to come, in spite of the forest fires and normal cutting processes. It has been impossible to determine the amount of tamarack in this region, although a number of foresters familiar with the tamarack areas have been questioned. An estimate given ran up into the millions of dollars.

When the Larch Sawfly began its depredations in 1908 there was great concern among the lumbermen. The presence of this insect was first noted in August, 1909, though from the dead and dying tamaracks seen the pest must have been at work during the two or three preceding years. At the present time there are, to my knowledge, three areas of infestation in Minnesota,—one at Itasca Park (a thirty-five-square mile tract around Lake Itasca, the source of the Mississippi), one at Cloquet, where the State Forestry Experiment Station is located, and another near Ely in the United States Government reserve. Unfortunately the writer has examined personally only the area at Itasca Park, and there not in the breeding season, but each of two years just as the larvæ were leaving, or had, for the most part, left the trees.

The work on the insect has been done almost entirely in the insectary. Several hundred cocoons were gathered in the spring of 1910, but from this number only 125 adults were reared, and of these it is interesting to note that three were males, a larger percentage than Doctor Hewitt found in his work on the Larch Sawfly in Europe, although perhaps with a larger number reared a smaller proportion of males might have appeared.

One species of Hymenopterous parasite was reared, which occurred in large numbers. I estimated that 10 to 15 per cent of the cocoons showed the presence of this parasite. Mr. C. T. Brues identified it as *Diglochis* sp.

Prof. R. H. Pettit, of East Lansing, Mich., learning that work was being done on this sawfly, kindly sent me a fungous preparation to scatter among the larvæ as they were descending the trees to enter the soil. Unfortunately, this fungus arrived after the cocoons were well formed, but in spite of this a few experiments were started, and by September 1 the fungus had spread considerably. This fungus, however, seems to be almost identical with the one found by me this summer under natural conditions. In one small area I found as many as 5 per cent of the 1909 cocoons infected.

The season of 1910 in Minnesota was the driest in the history of the white man. In Itasca Park where, in former years, the mosquitoes had been unbearable, in 1910 no mosquitoes were present, even in the usual swampy regions of the park. I give this to show how dry it was. Now, whether because of this excessive dryness or not, the Larch Sawfly larvæ did not remain on the tamaracks as long as they had in previous years, leaving while the trees still showed green. Also, the cocoons were considerably smaller than they had been in previous years. It seems, then, that the tamaracks here will have a little respite next year from the gross attacks of these pests. The other regions of infestation, according to reports received, did not manifest any such peculiarity.

PRESIDENT SANDERSON: Any discussion?

MR. HUNTER: Doctor Hewett sent us from England 340 pupæ of the Larch Sawfly, and we placed them in the ground. Some thirty of them emerged as females, and the rest either did not emerge, or were parasitized, and we got no males at all. We attached them to larch cuttings, kept them green, but were unfortunate in getting no oviposition.

Adjourned.

Afternoon Session, Thursday, December 29, 1910

The session was called to order at 1.30 p. m. and after the transaction of business the reading of papers was continued.

PRESIDENT SANDERSON: The first paper will be presented by Mr. Swenk,

A NEW SAWFLY ENEMY OF THE BULL PINE IN NEBRASKA

By MYRON H. SWENK, *Lincoln, Neb.*

[Withdrawn for publication elsewhere.]

PRESIDENT SANDERSON: Is there any discussion on this paper?

SECRETARY BURGESS: I would like to ask Mr Swenk in regard to the bacterial disease, if he finds it present where there is only a small number of caterpillars, or whether it is present only during severe outbreaks.

MR. SWENK: I think you will find some disease when caterpillars occur in small numbers but it is more common when many are present.

PRESIDENT SANDERSON: The next paper will be given by Mr. O'Kane.

CONTROL OF THE APPLE MAGGOT BY PICKING UP DROPS

By W. C. O'KANE, *New Hampshire*

The Apple Maggot, *Rhagoletis pomonella* Walsh, continues to be one of the troublesome fruit pests in the New England States and in eastern Canada. Of the apple enemies in this region it is probably the most serious, and unquestionably the most difficult for the grower to handle.

For the past year and a half the New Hampshire station has been at work on this insect. The investigation is still in progress. But some interesting facts have come to light this season.

Among these are the results of a series of experiments in the matter of control by picking up drops. Since these particular results have a definite economic bearing, they seem worth presenting in brief summarized form at this time in advance of detailed publication at a later date.

Ever since it was found out that the maggot matures in the drops, and goes from them into the ground to pass the winter, the usual advice to the grower has been to keep the drops picked up. This has been, and still appears to be, the most vulnerable point in the life round of this insect.

But what do we mean by keeping the drops cleaned up? How often must the fallen fruit be gathered? Offer this remedy to a dozen fruit growers, and they will give it half-a-dozen different interpretations. In conversation with, and reports from, many growers, I have found that some of them considered that they were keeping the drops picked up if they cleaned up the orchard once or twice in a season; others rejected the remedy because they inferred that the scheme involved a cleaning up once or twice a day.

It has not been possible to offer the grower specific instructions, for there are no records on which to base a definite program.

It is quite conceivable that in a given case a remedy which required going over the orchard daily would be impracticable and uneconomic, while a clean up once a week, for example, if this would suffice, would easily be managed.

Our plans for the past season, therefore, in our work on the maggot, included a rather comprehensive series of experiments designed to determine definitely how often the drops must be picked up; or, in other words, how soon after the apple falls the maggots leave it to enter the ground.

At the outset it seemed reasonable to suspect:

First, that the period after the apple falls and before the maggots begin to leave it would vary with different varieties of apples.

Second, that the period would vary according to the comparative maturity of a given kind of fruit.

Third, that it would vary as the general season advanced.

With these possibilities in view the experiments were laid out as follows:

Infested trees were selected representing ten varieties of apples, ranging from early or summer fruit to winter varieties.

All the drops under all of these trees were gathered daily and were then so disposed as to afford the following information for each of the ten varieties:

First, the number of drops gathered each day.

Second, for each successive week throughout the season, the total number of larvæ issuing within the first twenty-four hours from the time the apple falls.

Third, the same for the second twenty-four hours, the third twenty-four hours, and so on up to the eighth day.

Fourth, throughout the season selected lots of apples were kept under observation until they rotted, and data recorded showing the number of larvæ issuing the second week after the apple falls, the third week, and so on.

The ten varieties considered in the experiments were as follows:

1. Early Harvest, season, late July and early August.
2. Red Astrachan, season, late July to September.
3. August Sweet, season, August and early September.
4. Sops-of-Wine, season, August to early October.
5. Porter, season, September to November.
6. Russet Sweet, season, September to November.
7. Jersey Sweet, season, September to November.
8. Gravenstein, season, late September to November.
9. Westfield, season, October to winter.
10. Winter Sweet, season, October to winter.

The number of drops observed averaged about two thousand for each variety. The total number was 20,230. In considering certain results the Russet Sweet is omitted because the trees of this variety proved to be rather sparingly infested.

Summaries only of typical varieties will be given here.

The August Sweet is a good example of an early or summer apple quite generally infested. In this apple, at the beginning of the season, a few maggots emerged from drops within the first seven days, a very small number within the first and second twenty-four hours.

The ratio, however, is only thirty-eight maggots emerging the first week per thousand drops.

As the season progresses the number emerging the first seven days steadily rises, until it reaches a maximum of 730 per thousand drops at the end of this variety's season. In general, throughout the season, there is a slight but steady increase from the first to the seventh twenty-four hours of each week.

Taking up now the performance for the second and succeeding weeks that the drops were off the trees: In the early part of the season we find that the number of larvæ emerging after the first seven days rapidly rises to a maximum the third week after the apple falls, and then quickly diminishes to a comparatively small number the fifth and final week.

This rule holds good for every lot through the season of this variety, but as we get farther along the apples rot very soon after they drop, so that the third week off the tree finds them completely decayed, and consequently no more larvæ issuing.

Summing up the entire season records for this variety, and taking an average of all the drops observed, we find that for the first twenty-four hours after the apple falls, eighteen larvæ emerge per thousand drops; for the second twenty-four hours, seventeen larvæ emerge; for the third, twenty-two larvæ; for the fourth, twenty-five; for the fifth, eighteen; for the sixth, thirty-one; and for the seventh, forty-three. Thus we have for the first seven days after the apple falls a total of 174 larvæ emerging per 1,000 drops.

Again, taking an average of all the lots observed, we have for the second week after the apple drops a ratio of 988 larvæ per thousand drops; for the third week a ratio of 4,515 per thousand drops; for the fourth week, 1,299; and for the fifth week, 22.

For the whole season in this variety the total number of larvæ issuing per thousand drops was 6,898.

Considering now one of the earliest of the fall apples, the Sops-of-Wine, we find parallel results, but with the exception that the first seven days after the apple falls show proportionately a smaller number of maggots emerging, the season average being fifty-nine larvæ per thousand drops. In the second week this ratio becomes 710 per thousand; in the third week, 2,189 per thousand; in the fourth week, 1,473; and in the fifth week, 120.

The Porter gives a similar performance. Here the season average shows 12 larvæ emerging per thousand drops the first week after the apple falls; 242 the second week; 579 the third; 392 the fourth; and 67 the fifth.

Ranking as a little later fruit than the Sops-of-Wine, but still in the

class of fall fruit, the Jersey Sweet exhibits results that fall in line with the others. Comparatively few larvæ emerge in any one of the first seven days, the average number per thousand drops being 4 for the first 24 hours; 2 for the second; 2 for the third; 5 for the fourth; 6 for the fifth; 8 for the sixth; and 12 for the seventh. Thus there is a considerable increase toward the end of the seven days, but the total for the first week, taking an average of all the apples observed, is 39 larvæ per thousand drops. This number rises to a maximum of 2,555 larvæ per thousand drops in the fourth week after the fruit falls, and then diminishes to 8 per thousand the eighth week.

In the Winter Sweet we have an apple that belongs in the class of genuine winter fruit. In this variety practically no maggots appear until the apple has been off the tree for five weeks. The ratio is only 2 larvæ per thousand drops the first week; 1 the second; 7 the third; 5 the fourth; and 5 the fifth. For the sixth week the number increases to 33; for the seventh 46; for the eighth 78, which is the maximum; for the ninth 74; for the tenth 19; and for the eleventh 11.

At this point, an examination of the records gives definite answer to three questions connected with control of the apple maggot by picking up drops; as follows:

First, the summer or early fall fruit is of such character that a much larger percentage of maggots finds it possible to mature in it than in late varieties. From other records on hand it might be shown that the August Sweet and the Winter Sweet handled in these experiments did not differ widely in the average number of egg punctures per apple, Nevertheless the former, an early variety, gave for the season an average of 6,898 maggots emerging per thousand drops, while the latter, a winter variety, gave a ratio of only 281 maggots per thousand drops. In other words, the early fruit needs particularly to be watched by the grower.

Second, whatever the variety, the drops that first fall will mature the most maggots. If we examine representative lots in each variety and compare the total number of larvæ emerging from apples that dropped early as compared with those that dropped late, we find that there is a steady decrease as the season advances. This means, of course, that whatever the kind of fruit, the grower must not neglect the early drops.

Third, there is little need to pick up drops after the middle of October in the latitude of southern New Hampshire. Early varieties have passed out of existence by this date, and late drops, though badly infested, do not mature many larvæ.

This leaves for consideration the main question: How often must the drops be gathered?

A survey of the records indicates that to answer this question it is advisable and practicable to group the apples into three classes: early or summer varieties; fall varieties; and late fall or winter

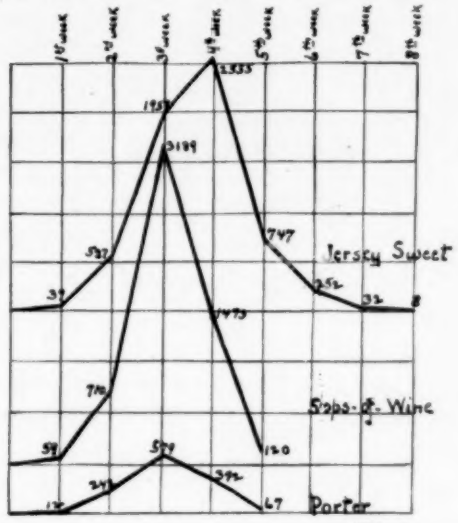


Fig. 1

varieties. The question is easier if we chart the average performance of the varieties observed.

So doing, we find that the August Sweet, Early Harvest and Red

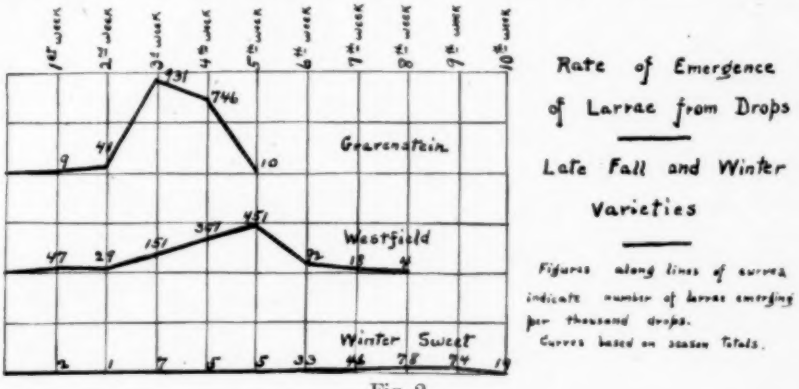


Fig. 2

Astrachan, typical of summer fruit, describe a curve that rises fairly rapidly the first week. The Early Harvest shows the sharpest rise, and is also the earliest fruit. The Red Astrachan shows the least angle of rise, but, in proportion to the total, this angle is considerable. Evidently the first week is productive of trouble in this class of fruit.

The Jersey Sweet, Sops-of-Wine and Porter, typical of fall fruit, exhibit a slight rise the first week, and a much greater one the second. Here, evidently, we may safely make our interval longer.

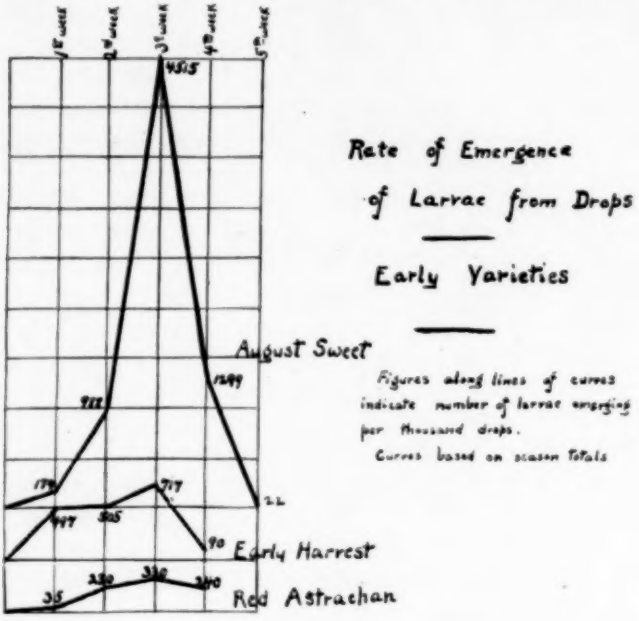


Fig. 3

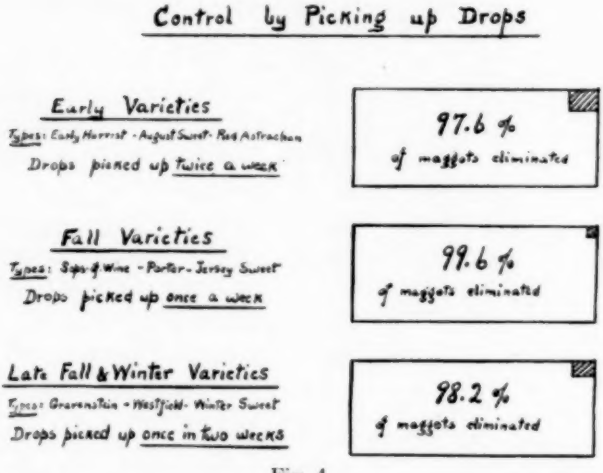

Control by Picking up Drops
Early Varieties
Types: Early Harvest - August Sweet - Red Astrachan
Drops picked up twice a week
97.6 %
of maggots eliminated
Fall Varieties
Types: Sops of Wine - Porter - Jersey Sweet
Drops picked up once a week
99.6 %
of maggots eliminated
Late Fall & Winter Varieties
Types: Gravenstein - Westfield - Winter Sweet
Drops picked up once in two weeks
98.2 %
of maggots eliminated

Fig. 4

The Gravenstein, Westfield and Winter Sweet show varying curves, depending on the lateness of maturity of the variety, but they have in common a slow rise for the first two weeks.

Bearing in mind that any plan of control proposed must be practicable and economical for the grower, the following program is offered:

With early or summer fruit the drops should be picked up twice a week. With the typical varieties handled this last summer, this frequency will eliminate 97.6 per cent of the maggots that would otherwise have matured and entered the ground.

With fall varieties the interval may be made once a week, giving results of 99.6 per cent of the maggots eliminated.

With late fall and winter varieties the drops should be picked up once in two weeks, giving results of 98.2 per cent of the maggots eliminated.

PRESIDENT SANDERSON: The next paper will be presented by Professor Osborn.

SOME NOTES ON INJURIOUS LEAF HOPPERS

By HERBERT OSBORN, *Columbus, Ohio*

[Withdrawn for publication elsewhere.]

PRESIDENT SANDERSON: Discussion of this paper? The next paper will be given by Mr. R. L. Webster of Ames, Ia.

NOTES ON THE WHEAT-HEAD ARMY-WORM (MELIANA ALBILINEA HÜBNER) AS A TIMOTHY PEST

By R. L. WEBSTER

Recent injury. During the past year much damage to timothy has been caused by the wheat-head army-worm in Iowa. The most serious damage was in the northern half of the state, although the insect was fairly common elsewhere. This outbreak extended into Minnesota and eastern South Dakota, so I have been informed.

Appearance of the injury. The larvæ gnaw into the heads of timothy, wheat, rye, other small grains, and some of the wild grasses, but they prefer timothy to anything else. The damage is mainly to the timothy seed crop, since the larvæ eat the seeds. Where the injury is severe the hay crop may be considerably affected. The larvæ begin to feed at the bottom of the head and work upward, sometimes eating only one side, sometimes taking all but the stem, allowing the chaff to fall to the ground.

Life History

There are two generations in Iowa. The first brood of larvæ feeds mainly on timothy heads, while the second feeds largely on a number of wild grasses, taking the second growth of timothy whenever the larvæ can find it.

The insect winters in the pupa stage in the soil. The moths emerge in May. This spring I found eggs on the base of timothy plants, tucked under dried leaves there. Previously eggs had been found only in the sheath of some of the food plants in the summer. None were found in that position in the spring. The young larvæ appear about May 20 and begin to feed on leaves of timothy plants. They were found only on timothy early in the year. When the timothy heads appear the larvæ go to them.

The injury to timothy becomes conspicuous about haying time, when the larvæ are about mature. The larvæ go to the ground in July, pupate, and the moths emerge early in August. We began to look for eggs on the base of timothy plants in August, where we had found them in the spring. Not until we began to examine the sheath of the plants did we find eggs. The eggs were deposited in single, double or even triple rows, as Riley observed.

Eggs hatched in the insectary in three to ten days. The larvæ began to appear outside about the middle of August, and were found as late as October 15. When mature the larvæ go into the soil, spending the winter as pupæ.

Food Plants

Previously this insect had been recorded from most of the small grains, as the following list indicates: Wheat, timothy, barley (Lintner), rye, oats (Riley), sweet corn, sorghum (Miss Murtfeldt), wild rice (Chittenden), Indian corn (Forbes). The grass-feeding habits of the larvæ had been noticed by Riley, Osborn and Smith, but I have found no records of any particular grasses as food plants. In the Iowa work the following grasses were found to be eaten, either the heads or the leaves being affected, or both. They were: blue stem (*Andropogon furcatus*), Indian grass (*Sorghastrum nutans*), barnyard grass (*Echinochloa crusgalli*), green foxtail (*Setaria viridis*), yellow foxtail (*Setaria glauca*), red top (*Calamagrostis canadensis*), awned wheat grass (*Agropyron caninum*), *Agropyron* sp., and squirrel tail grass (*Hordeum jubatum*). Eggs have been found in the sheath of speltz and *Elymus robustus* (robust lyme grass). These also are probably food plants.

Distribution

Although the species was first noticed by European writers, it is not known to occur outside of America. To the north the moth has been taken from Nova Scotia to Alberta, to the east in Delaware and New Jersey, to the west at Glenwood Springs, Col. (Barnes), and southern Arizona (Barnes). According to Sir George F. Hampson the species occurs at Mexico City, Mexico; Coquimbo and Mulchen, Chili; and Florenzia, Argentine. Buenos Ayres, Argentine, was given as the source of Hübner's type.

Natural Enemies

Dipterous parasites. Three tachinids were reared from the larvæ. Two of these, *Winthemia quadripustulata* Fabr., and *Euphorocera claripennis* Macq., are common species, and have been reared from many other hosts. The first species was by far the more numerous. It was very abundant in the summer of 1910, but was not found at all that fall. The third species, *Metachæta helymus* Walker, was more rare. It was reared in the fall only. The determinations are by Mr. D. W. Coquillett.

Besides these three Riley recorded another tachinid as parasitic on the wheat-head army-worm. This is *Frontina frenchii* Will.

Hymenopterous parasites. In the summer of 1910 an egg parasite was found, which has never been recorded. Mr. A. A. Girault tells me that this is a new species, and he has given it the manuscript name of *Pentarthron retorridus*. It was first seen August 23 by the writer, when a single specimen was observed ovipositing in eggs of the wheat-head army-worm. Afterwards it was reared abundantly, emerging August 30 to September 14.

The hymenopterous parasites of the larvæ were less numerous than the tachinid parasites. Of these, *Microgaster auripes* Prov. (H. L. Viereck determination) was the most common.

Another parasite, somewhat less common, was a species of Microplitis, which Mr. Viereck says is new. This parasite affected the younger stages of the larvæ only. A secondary parasite was reared from one of the Microplitis cocoons, a new species of Mesochorus, according to Mr. Viereck.

One specimen of *Paniscus geminatus* Say (Rohwer determination) was reared in 1910.

My father, F. M. Webster, writes me that *Apanteles læviceps* has been reared from this host in New Mexico by Mr. C. N. Ainslie.

Riley had previously recorded two species from this host, which

were not reared by us. These were *Anomalon apicale* Cresson and *Ichneumon brevipennis* Cresson.

Control Measures

Clean culture. Since the larvæ, especially those of the second generation, feed largely on some of the wild grasses, the presence of those grasses in meadows and along roadsides is a direct aid to the pest. A whole field might be stocked with these insects from those which breed along the roadsides, both on the volunteer timothy and on the grasses. The farmer should look to the roadsides and fence rows, as well as the fields, and try to keep these grasses down as much as possible. Clean culture is one very essential factor in the artificial control of this pest.

Fall plowing. During the first two weeks of September, larvæ are at work on young timothy plants in meadows, as well as on foxtail and other grasses. Sod that is turned under at this time would effectively bury and kill the young larvæ. Any that might escape would find nothing to eat.

If it is impracticable to turn under a meadow in the fall, or if it is to be kept for another year in sod, a measure such as early fall pasturing would be advisable.

Early fall pasturing. In the summer of 1909 it was found that pastured meadows were often less injured than those which were not pastured. Since the young larvæ of the second generation are at work in meadows from the middle of August on, it is easy to see that rather close pasturing early in the fall would keep the grass down so well that the larvæ would be starved out. Doubtless many timothy stems containing eggs would be eaten, eggs and all, and probably some of the young larvæ would share the same fate.

Late spring pasturing would have the same effect, but the eggs and young larvæ do not appear until late in May, too late for pasturing, if hay is to be cut from the field.

A large number of counts were made in pastured and unpastured meadows, which showed the benefit obtained by fall pasturing. In the counts usually 500 or more timothy heads were taken at random, keeping track of the number that showed injury by the wheat-head army-worm.

A few examples of these counts follow: In a two-year-old, unpastured meadow near Woodburn, Iowa, 20 per cent of the timothy heads were injured. Another nearby meadow, also unpastured, showed 20.6 per cent injury. A third unpastured meadow was infested to the extent of 21.1 per cent. In a meadow eight or ten years old, which

had been pastured in the spring and fall of every year, 6.1 per cent of the heads were injured, in a count of 1,500 heads. Another meadow, pastured only in the fall, showed 3.6 per cent injured heads.

In a one-year-old clover and timothy field at Dexter, Iowa, 28.6 per cent injured timothy heads were found in 1909. That fall the field was heavily pastured, and the larger part of it was plowed in the spring and put into corn. On July 1, 1910, only 10.2 per cent of the timothy heads were injured in the part of the meadow that remained. But the greater part of the field had been turned under that spring. The moths that emerged in the spring, then, would deposit their eggs in the timothy that remained. Had the field been left unplowed, the average injury in 1910 would doubtless have been much less than 10.2 per cent.

Two meadows near Ames, one pastured and the other unpastured, were compared in the fall of 1910. Both were badly infested that summer. Stock were put in the one field between September 6 and 10, and they ate the grass down fairly close within ten days or two weeks. October 4 this field was compared with the unpastured field, and an amazing contrast was found between the two. No larvæ were found in the pastured field, but they were quite common on the second growth of timothy in the other field. This second growth had been kept well eaten down in the pastured field. Later observations showed the same result, no larvæ in the one field and injured timothy heads and plenty of larvæ in the other.

If a meadow is to be pastured, stock should eat down the infested fields fairly close during the first half of September, certainly before the 15th. Where timothy and clover are grown together, care must be taken that the pasturing is not so close that the clover is exposed to injury during the winter. A field might be pastured fairly close before the middle of September, and left free of stock the rest of the fall, giving the clover some chance for growth after that time

To summarize, fall pasturing is the best measure that we know of against the wheat-head army-worm in timothy; early fall plowing and clean culture are measures next in importance.

PRESIDENT SANDERSON: Discussion of this paper?

MR. SMITH: I should like to ask Mr. Webster how many adults he bred.

MR. WEBSTER: Thirty or forty.

MR. SMITH: The reason I ask this question is that in our experiments we have found out that only a very few could be actually raised, and so got very little information as to species, and as a matter of

fact we could not tell whether we had two or three species to deal with. It is quite likely that there are three different species. One authority says that the species he has dealt with is the same all over the country. Now, if Professor Webster has those specimens still, I should like the privilege of examining them, and see which of the particular forms he has found and bred. Of course, it is likely that all those are of one species, but it will help us to get some information.

MR. WASHBURN: An army worm in Minnesota this year was extremely destructive to timothy in the southern part of the state. I believe at least two thirds of the timothy seed in Minnesota was destroyed.

PRESIDENT SANDERSON: I think this finishes the papers to the symposium on spraying machinery. Professor Ball is not here, but has sent his paper, which will be read by the secretary.

SPRAYING APPARATUS FOR ORCHARD INSECTS

By E. D. BALL, *Logan, Utah*

While it is possible to do thorough orchard spraying with nearly all makes of spraying apparatus on the market at the present time, still there are many things to be desired before the highest efficiency will be reached.

There is a movement on foot at the present time to standardize the requirements of the different spraying outfits and to make tests of their comparative efficiency. This is a good movement and one which the entomologist should encourage in every way possible, and now is a very opportune time for us to discuss the problems connected with spraying apparatus in general and point out the lines in which improvement should be made in order to increase efficiency. No doubt many improvements and changes will be made as the result of these tests from time to time and if the lines along which improvements are needed are pointed out, it may assist the manufacturers to more rapidly reach the desired ends.

The construction of pumps was long ago reduced to a science and there is little room for improvement along general lines of pump construction. The adaptation, however, of some of these principles to uses in connection with high pressures and different spray mixtures needs further consideration. The present line of barrel pumps scarcely come within the class of orchard sprayers. A few of the larger ones with large air chambers and arrangements whereby the packing of the plunger may be tightened at any time are capable of developing and maintaining sufficient pressure to be efficient

within the limits of their capacity. The double-acting hand-power pumps are usually efficient instruments, provided the air chamber is of sufficient size. Many of the present models are equipped with air chambers too small to equalize pressures above 200 pounds. In the power outfits much loss has been occasioned through lack of rigidity in the construction of the frames, which often yield under trying conditions to which they are subjected in orchard work. Many of these outfits are put out with too small air chambers for the pressure that they are capable of developing. Provision should be made in all outfits expecting to handle pressures above 100 pounds whereby air can be forced into the chamber under pressure before pumping of liquids is commenced, thus giving a much larger air cushion than can be obtained where liquid is forced into the air chamber and only a small amount of air is compressed. This problem has been solved by different manufacturers in different ways and should be a requirement of all outfits in the future.

One of the most annoying features of present pump construction is the liability of trouble with the relief valve. The constant friction of spraying solutions passing through the valves soon wear the delicate parts until it is impossible to make adjustments and still allow of sufficient escape to handle all the liquid when the nozzles are shut off. Unless there is sufficient room to handle the entire capacity of the pump with ease, the pressure runs up when the nozzles are turned off and the pump is thereby subjected to severe and useless strain which only results in more rapid wearing of the affected parts. Many devices have been designed to overcome this objection and some of them are fairly successful. A device on exhibition at the recent tests at Council Bluffs, in which the entire matter was obviated by regulating the amount of liquid taken in through the suction pipe and doing away with the escape valve, suggests the possibility of entirely obviating these defects in the future. While probably improvements could be made on the present apparatus, the principle of shutting off the liquid when the nozzles are cut off rather than providing for an escape is the correct one, thus obviating almost all unnecessary wear on the engine and pump. In this connection, it has already been suggested by different workers that the outfits of the future will probably not pass the spraying liquid through the pump at all. One of the most serious drawbacks to efficiency of spraying apparatus at the present time is the necessity of fitting them to resist the corrosion of the different spraying compounds. If the necessity of passing these through the pump is obviated, it will probably both cheapen and simplify pump construction. The prime requisites of successful orchard work are unlimited power and constant pressure, and, on this account, spray-

ing outfits depending upon traction for their motive power will find little place in Western orchard work.

The equipment of the orchard outfit is, if anything, more important than the pump itself and must vary greatly to meet the needs of the different lines of work. For Western orchard work, every outfit should be equipped to meet the requirements of the codling moth spray and then with slight modifications it can be adapted to the other lines of work in which it will be used. This equipment should consist of twenty-five to thirty feet of ½-inch seven-ply hose with small inconspicuous couplings capable of withstanding pressures up to 250 to 300 pounds. These couplings should be capable of being tightened on to the hose by heavy screw threads. On the end of the hose should be placed a light bamboo pole eight to twelve feet long. The shorter lengths are best equipped with brass inside rods, while aluminum is probably better for the twelve-foot poles on account of its lightness. In any case, the couplings connecting the rod and pole should extend down over the bamboo for a considerable distance and be capable of tightening as the wood shrinks, so that there is no possibility of the rod turning inside of its wooden cover. Such a connection as this also prevents the danger of breaking the threads of the rod through the excessive weight of the heavy hose. At the bottom of the bamboo pole there should be a cut-off which works instantaneously with a single motion of the hand and in which the lever projects as little as possible. In fact, it is very important to have the entire coupling of hose and pole as neat and compact as possible, so that it can be readily passed through the hand without catching in the ordinary spraying manipulations. The end of the pole should be equipped with a small compact angle to which the spray nozzle can be attached. Some nozzles are now fitted with their own angle and in certain cases this may be preferable. On the other hand, a separable angle admits of change for different kinds of work and different nozzles.

The nozzle is probably the most important part of the entire outfit, as without the proper nozzles many outfits costing from $200 to $300 have been rendered inefficient and thousands of dollars of loss entailed. There seems to be a very wide misunderstanding among the various manufacturers at the present time as to the exact requirements of an efficient nozzle, and, while we have many types and innumerable modifications, there does not seem to be a clear understanding of the object sought. Especially is this true of those of the driving spray type. The two major requirements of the driving spray are capacity and penetration and a third factor to be considered is economy of liquid. Only two persons can work to advantage on one spraying

outfit, and much more efficient work will be done with the driving spray where there is only one nozzle to each operator. Therefore, driving spray nozzles should have sufficient capacity, so that two of them will use nearly the minimum amount of liquid ordinarily delivered by a power sprayer. The best results with the driving spray are accomplished where fine drops are driven to a distance of five or six feet before breaking into a mist, and this can only be produced where the aperture is large enough to give considerable pressure to the liquid outside. The smaller the aperture the more quickly the spray will fog and the less penetration. If, on the other hand, too large an aperture is used, the drops will be too coarse for good work. Nozzles of the Deming "Bordeaux" and the Bean "Double" type seem to have approached fairly close to the limit of capacity and efficiency in this type of construction. Many of the other so-called Bordeaux nozzles have so small an aperture that only a small amount of liquid can be handled through them and this fogs very soon after leaving the nozzle. There are some advocates of the Vermorel type with a large enough aperture so as to give considerable penetration. In the writer's experience, this type of nozzle, although capable of doing fairly good driving work, is quite wasteful of liquid, as, in thorough spraying, practically all the liquid of the flat spray can be so directed as to be driven directly into the blossoms as they are arranged on a given branch, while with the cone-shaped spray, if one side is driving straight into the blossoms, two thirds of the circle will often be too far from any other branch to be effective, or sometimes lost in space. These larger Vermorel types such as the "Friend" and "Mystry" are, however, much to be preferred for cover or mist spraying to the batteries of smaller sized nozzles formerly used. There is a great deal of room for improvement, however, in the distributing power of these different types of sprays. There is scarcely one of the flat spray type but what delivers the liquid with very unequal pressures in the different parts of the spray, while the cone-shaped type could probably be improved if it could be made a solid cone of equally distributed spray rather than a hollow one. A great amount of useless expenditure is occasioned by making nozzles with soft-wearing surfaces. The nozzle of the future will undoubtedly have hardened wearing surfaces that are easily and cheaply renewed.

The tower is becoming more and more important in Western spraying—in fact, a very large percentage of the Western spraying of lime and sulphur is now done from some form of platform or tower. Any apparatus which places the operator on a level with his work tends greatly towards rapidity and efficiency of performance. The disadvantages of the old-fashioned square-posted tower with a railing

around it are numerous. The width makes it difficult to get through the orchard without injuring the trees and the railing is constantly in the way of the operator in handling the back end of his pole. The tower of the future will probably be constructed with a narrower base and coming to an apex much like the present windmill tower, on top of which will be placed a small round platform with a footrail and in the center a single iron post with a revolving seat similar to a miniature saddle or a racing bicycle seat. With this type of seat, the operator can cling to the seat by clasping it with his legs and with his feet on the small round platform, will be free to move around and at the same time have perfect freedom in handling his pole and hose. Where two operators are spraying from one machine, such a platform can be constructed at each end of the outfit. These small steel towers if sufficiently braced could be made removable by removing four bolts or so that they would fold down on removing two, which would enable the outfit to quickly pass through otherwise inaccessible places.

As a final word, the writer would suggest that the greatest difficulty met with in practical work to-day is the fact that so few of the manufacturers place their machines in the field fully equipped for the work which they are required to do. The writer has time and again been called on to assist in starting an outfit, only to find that it lacked a number of small, but necessary parts, such as cut-offs, angles, satisfactory hose-couplings and, in many cases, efficient nozzles.

PRESIDENT SANDERSON: The next paper will be read by Mr. Worthley.

SPRAYING OF WOODLAND AND SHADE TREES

By L. H. WORTHLEY, *Boston, Mass.*

The subject which has been assigned to me is one of great economic importance in its relation to the suppression of leaf-eating insects. In all the world's history, I believe there is no parallel to the heroic fight being made by the state of Massachusetts in her efforts to protect the forests and shade trees within her borders from the deadly ravages of the gypsy and brown-tail moths. Thousands of men have been employed, and millions of dollars expended already, and the battle is still raging.

Of the various methods employed since the early nineties, in my opinion, none has proven more effective than spraying with arsenical poisons. While spraying operations have been carried on in Mas-

sachusetts since 1892, it is only within a comparatively brief time that it has been on an extensive scale, so much so that it has been necessary to improve our spraying apparatus, so that a large amount of work could be done in a short space of time. In this year's work, approximately 500 tons of arsenate of lead were used in the suppression of the gypsy and brown-tail moths in Massachusetts, which necessitated the use of 200 power sprayers and 275 hand outfits. When spraying was first carried on in this work, the only apparatus which we had were hand pumps, ½-inch hose, Bordeaux or Vermorel nozzles, furnishing only mist spray. These pumps were mounted on barrels, which were in some cases mounted on wheels, and oftentimes it was necessary to put them in express wagons. These were considered at that time very satisfactory, and this size of apparatus was used in the work until 1900. Although considerable experimental work was carried on by the State Board of Agriculture at that time, few improvements were made.

The work against the moths by the state was stopped in 1900 and the insects allowed to go unmolested until May, 1905. Necessarily, the problem grew much larger, and the infestation in some localities was very severe. When the work was resumed under the direction of the Commonwealth, it was necessary to have improved apparatus. Owing to the fact that power sprayers had been introduced in 1895, and used by Mr. J. A. Pettigrew with the solid stream method, that is, spraying the trees from the ground, we considered that it was necessary for our department to have larger apparatus than had been previously used in the work. Several power sprayers were introduced by different manufacturers, their motive power being gasoline instead of steam as was used by Mr. Pettigrew. These machines did quite effective work, but they were not much of an improvement over the hand apparatus, as it was necessary to use the same small hose, Bordeaux and Vermorel nozzles, and climb the trees. They were not capable of maintaining pressure that would allow us to use a solid stream and give good results. The engines which were used on these sprayers were of the stationary type, and, owing to the fact that they had but one cylinder, so much vibration resulted that the apparatus depreciated rapidly. Duplex pumps were used also, and proved to be very unsatisfactory, as they did not give a steady pressure, even when small hose and mist nozzles were used.

Owing to these facts, it was necessary to induce the manufacturers to give us better and larger apparatus that would be more adapted to the work, and in 1907 and 1908 larger outfits were available. They were mounted on dead axle wagons, 400-gallon tanks, heavy triplex pumps, and mostly two-cylinder marine engines, although some of

them had two-cylinder stationary type. These machines gave much better results, as we were able to maintain higher pressures, and use the solid stream method in spraying woodlands, and, in many cases, shade trees.

As these machines were very heavy, they caused trouble in getting around in the woodland colonies, and placing them near pond holes where water was available; therefore, they did not give as good satisfaction as desired. These machines, however, could be filled by their own pressure from ponds, through a 2½-inch suction hose, and would deliver the solution at the rate of thirty-five gallons per minute, thus making an advance over the previous machines, but they did not do as well as expected, or give such results as were needed.

In 1909 and 1910, the State Forester's Department started experimental work along these lines. A power outfit was placed in the field last season, which proved more satisfactory than any previously used. It consisted of a platform spring running gear, 400-gallon "U"-shaped tank, triplex phosphor bronze pump, and four-cylinder marine type engine, capable of maintaining a steady pressure of 350 pounds. By using the four-cylinder engine much less vibration resulted, and the depreciation on the apparatus was greatly reduced. The pumps previously used were very heavy and bulky, and not calculated to maintain a pressure of over 250 pounds, so in building the new pumps, which were designed by the State Forester's Department, it was thought wise to use better material, and phosphor bronze was substituted.

The pumps are of cylindrical design, all flat surfaces being avoided, great strength and free passage of water being thus secured. The weight of these pumps, when completed, was about half that of those previously used. The agitators used in these outfits, up to the present time, have been propeller blades attached to an agitator shaft, running through the lower part of the "U"-shaped tank. These agitators were not entirely satisfactory, and for the coming season, we shall use more paddles, and feel that the settling of the lead in the bottom of the tank will then be very small. On these machines, the necessary pressure is determined by the length of hose which is being used in the work. One-inch marline-covered hose with full way coupling is used, and in lengths from 100 feet to 2,000 feet. This is determined by the size of the area which we wish to spray.

In order to spray woodlands and shade trees effectively, it is necessary to maintain 220 pounds pressure at the nozzle. We are spraying several thousand acres every year, and in one woodland colony, nearly 4,000 acres are being cared for, the average cost per

acre this year being $6.50. Ten pounds of arsenate of lead paste to 100 gallons of water was used at the beginning, and this amount gradually increased to fifteen pounds at the last of the season.

One other point must be considered in using power outfits. It is necessary to have the engine and pump work at all times when the solution is in the tank so that settling will not occur, for if poison is allowed to settle, it is very difficult to mix it perfectly again, and the poison will be unevenly distributed on the foliage. In woodland colonies after the thinning and creosoting methods have been applied, roads must be built, so that the apparatus can be used, and the colony sprayed with a reasonable length of hose. The building of the roads last year was done at a cost of 3 1-7 cents per square yard. We find it necessary to see that the poison is well mixed before weighing and placing it in the spray tank, because in numerous cases we have noticed that where large barrels of arsenate of lead have been allowed to stand for any length of time, the poison has settled to the bottoms of the barrels, thus making it very hard to mix properly when wanted for use. We are now experimenting with a mechanical device which can be attached to the outfit, worked by the power from the engine, to mix the poison thoroughly before it is taken from the barrel. If this is not properly done, the first half of the barrel will not have sufficient strength to give good results in killing the caterpillars.

The nozzle, which is used in our work, is another very essential point to be considered, as in previous years we have been obliged to climb the trees to a considerable extent, even when the solid stream was used. This was due to the fact that there was so much resistance in the nozzle that it would not give a stream of sufficient height, it being broken up and spread out immediately after leaving the tip of the nozzle. This year, we designed a nozzle, which has given excellent results. The first point which was considered was to eliminate as much of the resistance as possible, that is, having a full inch water-way direct to the tip. The shut-off and base of the nozzle, and the brass tubing running to the tip are each one inch internal diameter. At the top of this brass tubing is what is known as a "Hopkins," which stops the whirl of the water inside, and the tip is of an even diameter throughout, causing the stream to rise from twenty to twenty-five feet without breaking, as will be noted in the photograph. The proper length of the tips was a very hard matter to determine, and hundreds were made and tried out before the one giving the best results was selected, and by means of this straight water-way in the tip, we are able to spray ninety-five feet high. In our largest woodland problem this past year, we have experienced no trouble in spraying the greater part without climbing.

Through the efficiency of this nozzle, $2 per acre was saved in spraying a piece of woodland containing 3,018 acres. It is very essential that the operator of this nozzle shall use good judgment in directing the stream, so that the foliage will not be reached by it directly. He should hold it in such a position that the solution will reach the foliage as a mist, for if the force of the stream is applied directly to the foliage, the greater part of the poison will run off, and not sufficient remain to kill the caterpillars.

We have secured the best results in spraying woodlands the second year, when the undergrowth is allowed to grow up, and the poison which ordinarily falls on the forest cover is deposited on the undergrowth, within easy reach of the caterpillars. These machines are capable of filling through a 2½-inch suction hose in five minutes, or even less time, if pushed to their full capacity. In discharging, the average time is twelve to fourteen minutes, and nearly an acre is usually covered with one tank of poison.

A good comparison between the machines previously used and the one designed by this department is that in filling with the old machines, it took from eighteen to twenty minutes, and discharging was done in from twenty-five to thirty minutes. The saving of time in this operation is a large item in the work, although it is necessary for the men to be much more active in their movements and there is but very little time to lie idle while the filling process is going on.

In what is known as the North Shore work, that is, the woodlands in Beverly, Manchester and Gloucester, where between 3,000 and 4,000 acres are being cared for, and where we have been fighting the moths systematically for three successive years, there will be from 1,000 to 1,500 acres the coming season that it will not be necessary to spray. These colonies will probably need to be sprayed alternate years.

The work on the shade trees in our state, where the trees on 14,000 miles of streets must be treated in suppressing the gypsy and brown-tail moths, is a very large problem in itself. Previously, the trees that were sprayed were climbed, and treated with a mist spray, taking much time and with great expense, but by means of the more modern apparatus used this last season, all of the street trees in several towns and cities were sprayed with the solid stream, which resulted in a large saving of money. It has been often argued that not as good work is done with the solid stream on shade trees as with the mist spray, but in looking over the results which have been secured, very little difference can be observed. It is our belief that the solid stream will give as good results as mist spray, except in a few cases where buildings may be temporarily defaced by the poison. Some of the machines are

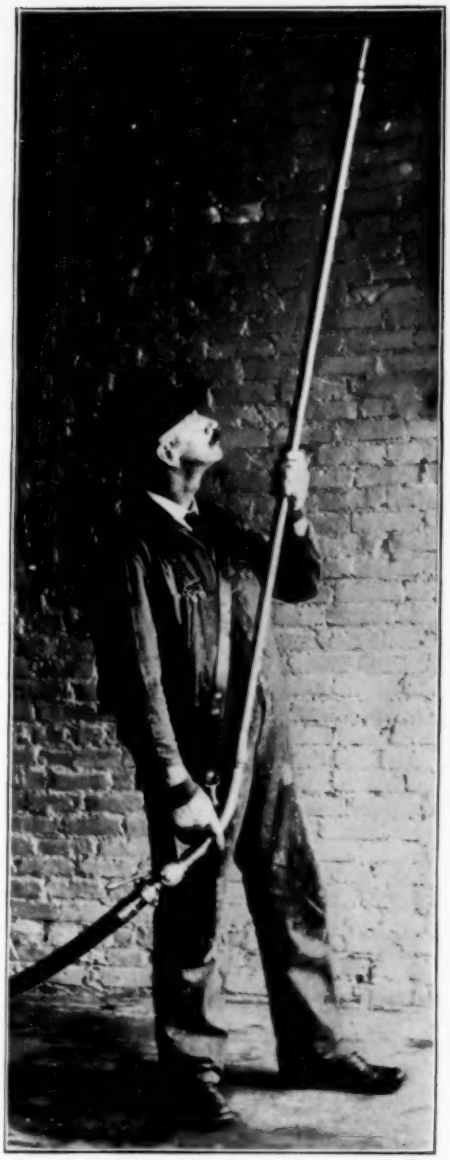
Gasoline power sprayer, built by State Forester's department, with four-cylinder engine and triplex pump, the latter designed by same department, capable of furnishing 300 pounds' pressure in woodland work. Weight of outfit, 3,000 pounds. (From Massachusetts State Forester's Report.)

U of M

OLD METHOD

NEW METHOD

The above illustrations show nozzle and shut-off designed by State Forester's department for woodland work, with ¼ inch straight tip; also the nozzle formerly used, 18 inches long. Note difference in spray, as the long nozzle is carrying stream higher before breaking into mist. (From Massachusetts State Forester's Report.)



Long woodland nozzle with strap attached, shut-off and shoulder strap, designed by State Forester's department for high, solid, straight stream spraying. (From Massachusetts State Forester's Report.)

fitted with what is known as "extension towers" which consist of tubing from fifteen to twenty feet long, carrying a nozzle at the tip. This method has been used mostly by the United States Government in roadside spraying in the moth-infested area.

In some cases, it is not possible to secure as good results with the towers as it is with the long nozzle, and this is particularly true when the wind is contrary.

In calculating the cost of treating shade trees and woodland areas, a reasonable amount must be allowed for depreciation of apparatus. We consider that 20 per cent should be allowed annually on the machines, and 50 per cent on the hose. The average cost of spraying shade trees, both large and small, is between fifteen and twenty cents per tree.

One other improvement which I neglected to mention, which will be used in this year's machines is the high tension Bosch magnetos instead of batteries for ignition, and mechanical oilers in place of gravity feed. The use of the magnetos will strengthen the power and the oilers will eliminate excess oil in the engine base.

From our experience the different spraying outfits may be rated as follows: First, the hand pump, agitation not good, expensive to use when much work is to be done; second, small power outfits, not much better than hand sprayers; if the proper agitation is secured too much power is consumed and not enough remains to give efficient results at the nozzle. We find that efficiency and economy must be considered at the same time, and high class outfits, alone, will give these results.

PRESIDENT SANDERSON: The next paper, by Mr. Worsham, who is not here, will be read by the secretary.

SPRAYING APPARATUS FOR SCALE INSECTS

By E. L. WORSHAM, *State Entomologist, Georgia*

The title of this paper designates a consideration of spraying apparatus and accessories, particularly with reference to their use in controlling the Coccidæ. Generally speaking, any good modern pump is equally well adapted to spraying both fungicides and insecticides. In certain respects, however, which are primarily concerned with the physical nature of the spray material, the efficiency of the different types of spray pumps is somewhat variable. The reason for this variation is hereinafter discussed more fully under the head of pump construction.

There is spraying apparatus of all kinds and sizes, and the selection of an outfit is, therefore, based on its service requirements. Beginning with the smallest of all, the bucket pumps which may be had for a few dollars, the sizes and costs will increase on a more or less graduated scale up to the 200-gallon power pumps which cost several hundred dollars.

Strong competition in the spray machinery business is responsible for the rapid improvement in the construction of pumps and accessories. It is now possible for the purchaser to obtain good, durable and efficient pumps from a number of manufacturers and at a cost entirely commensurate with their value. Individual operators have a large field in which to exercise their choice, though such choice would necessarily be founded more upon some peculiar mechanical device than upon cost.

Bucket and Knapsack Pumps

These two styles are grouped together because their field of usefulness is so limited. With sufficiently long leads of hose they may be used on small orchard trees, but they are designed and built ostensibly for use in spraying greenhouse plants and shrubs. Their relatively small cost places them easily within reach of all who have ornamental plants to protect, both indoors and out, from scale insects, and in this field they make valuable acquisitions to the garden, the greenhouse, and in the growing of small ornamental plants.

The bucket pump as a rule is constructed so as to extend into the bucket, to which it is attached by a clamp: a foot piece extends to the ground and by placing the foot upon this the pump is held in position while it is being worked. The cost varies from $5 to $10.

The knapsack pump being more portable and somewhat larger, is a more desirable contrivance for use in the sphere above assigned to the bucket pump. It is attached to the back after the fashion of a knapsack and is worked by a lever extending over the operator's shoulder. The details of construction vary between the different manufacturers, but the general plan is much the same in all. They are of five gallons capacity and are equipped with 3-8-inch hose to which any style nozzle may be fitted. The tanks are made of brass or galvanized iron and the prices are governed by the metal used in their makeup. The list prices vary from $10 to $18.

Barrel Pumps

Barrel pumps, as the name denotes, are pumps intended for mounting in barrels, and their size, cheapness and general efficiency for spraying on both large and small scale make them, perhaps, the most important

type of spray pump. When fitted out with good accessories they are capable of spraying the largest fruit trees under ordinary conditions and by far the larger part of all orchard spraying is done with pumps of this class. Practically the same principles are incorporated in the manufacture of the different makes, though the details of construction vary greatly.

It may be well in discussing this pump to consider what the essentials of a good pump are.

To begin with, it is necessary to have an air chamber to insure a steady spray, otherwise the spray would be intermittent and pulsating. The air chamber may be either separated from the working parts of the pump or combined with them. In some styles it is on top of the barrel, but in the more satisfactory types it is within, and in the latter the stability of the pump is greater. A large air chamber on the top of the barrel renders it top heavy, and this top heaviness is likely to be responsible for accidents when spraying on rough land.

One feature of the barrel pump that is yet far from perfection is the agitator. In most forms the paddle agitators are used, but these, while they are all that could be desired for spraying materials free of solid matter, will not and can not keep sprays such as the home-made lime and sulphur thoroughly mixed. The tips of the paddles describe an arc of about 45° and work so slowly that the lime quickly settles to the bottom with the result that the first part of the material as it comes from the barrel carries much more free lime than the last, which has but little.

The question of the agitator for barrel pumps is an important one and one that has not heretofore been satisfactorily solved. It is only in gas power sprays that this feature is perfected. However, for the materials now being used against scale insects which are uniform in composition and carry no solids, an agitator is wholly unnecessary.

The working parts of a pump, namely, the valves, valve seats, plunger and cylinder, should be made of metal resistant to the corrosive action of the spray material. These are usually of brass, bronze, or porcelain, substances not corroded by the action of the liquid.

A pump should be compactly built with all the working parts closely fitted so as to prevent leakage and attendant loss of power. All parts should be easily removable for cleaning purposes and to make repairs. Much trouble may be avoided by using only the best packing for the plunger. The standard asbestos is far superior to leather or cord, being more resistant to the caustic action of the spray and in every way more durable and satisfactory.

The spray pump market supplies a large number of different makes of barrel pumps. Those best known to the author are the "Deming,"

manufactured at Salem, Ohio; the "Friend," manufactured at Gasport, N. Y., the "Gould," at Seneca Falls, N. Y., the "Bean," at Cleveland, Ohio, and the "Hardie," at Hudson, Mich. The last has the pump mounted in the side of the barrel instead of the top, and this feature makes it particularly adaptable for spraying on rough steep hillsides. By building a frame work to the front trucks of a wagon and attaching the barrel thereto, the pump may be operated by the driver from the ground. The frame work being a continuation of the shafts, gives the barrel an angle which brings the pump handle to a position from which it can easily be worked by the driver. This pump when so arranged is especially valuable for use on land not really accessible to a wagon.

Any of the pumps above named are good, reliable makes, and with proper care will last indefinitely. They are sufficiently powerful to generate and consistently maintain pressure for the two leads of hose carrying a total of four nozzles.

Horizontal Pumps

This type of pump is designed for spraying on an extensive scale. It is larger and more powerful than the barrel pumps and is capable of supplying four leads of hose. The air chamber is of greater capacity and, therefore, capable of storing more air pressure than the smaller types. The plungers are usually differential and thus an equal pressure is exerted on both strokes, making the pumps double acting. With these, as with the barrel pumps, the principle of construction is practically the same. There are many differences of detail, and it is in the details that each manufacturer claims superiority over his competitor.

Horizontal pumps are intended for attaching to wagon tanks of from 100 to 200 gallons' capacity. They may also be bolted to a heavy lead and operated in connection with an ordinary fifty-gallon barrel. Primarily, however, they are designed for tanks and for heavy work on a large scale.

This style of pump may be, and usually is, operated by hand, but it is usually fitted up with a pitman or similar device for connecting to a gas engine. The Bean Pump Company are manufacturers of a pump of this kind that includes a heavy coil spring for equalizing the efforts necessary to operate the pump handle. On one stroke energy is stored into the spring by the pull against its resistance and the resultant compression, and in the return stroke the stored energy contained in the compressed spring is released and the expansion helps the operator in forcing the liquid into the air chamber against full gauge pressure.

The working parts of horizontal pumps are not immersed in the spray material as is the case with most pumps of smaller size. The air chamber is connected to the material supply by a piece of heavy rubber piping, and is filled by suction. Repairs are more easily effected than with barrel pumps which have to be removed from the barrels, sometimes when the latter are full of spray material, before the seat of the trouble can be reached.

The cost of the horizontal pump ranges from $25 to $50. Nearly all the pump manufacturers have their cheaper and their better grades with an accompanying price list to match.

Power Pumps

Power pumps are of two kinds, (1) gasoline and (2) compressed air or compressed gas. With these machines it is possible to maintain the air pressure at a higher and more constant figure than with hand motive power. The maximum degree of success in spraying against scale insects is obtained only when the spray is driven onto them in a finely divided state and with force. The greater the force the greater the efficiency of the work, all other conditions being equal. Power outfits meet this essential requirement better than those operated by hand, for the reason that they can maintain a higher pressure and hold it practically constant. For general efficiency and labor saving they are superior to other types, especially in large commercial orchards, parks, etc.

Gasoline Power Pumps

All the leading power pump manufacturers turn out regular power pump outfits and they are giving general satisfaction wherever used. The original purchase price is, of course, much higher than for hand pumps, but thereafter they may be operated at a smaller cost and the additional cost in the beginning represents economy in the end.

Power pumps can certainly maintain high pressure for four leads of hose and have a capacity of 200 gallons per hour. Their greater weight makes them ineligible for use on land of a rough or hilly nature, but on flat land they are the most efficient and most rapid sprayers on the market, and their value as time and money savers is being more generally understood and appreciated than ever before. They are cheaper, too, than at any time in the past. A spraying outfit with gas engine, pump, lead, hose, etc., may be bought for sums varying from $135 to $300. The gasoline engines may be used for other farm purposes as well.

One feature of the gasoline power outfits, wherein they outclass any other type of pump, is the matter of the agitator. By attaching

the agitator to the engine, the paddles may be run at a rapid rate of speed and the spray material kept in a violent state of agitation. Where home-made lime and sulphur or other materials carrying solid matter are used this form of power pump is superior to any other.

Compressed Air Pumps

This class of pump is of two kinds, *i. e.*, those that are air charged at a fixed station, and those that compress the air into a cylinder by means of an apparatus connected with the rear wheels of the spray wagon. Both of these types are worthy of recommendation under certain conditions. Where no part of the spray solution will settle out, as when miscible oils, prepared lime and sulphur, etc., are used, and no agitation thereof is necessary, pumps that are air charged at the renewal station are highly efficient. Pumps that depend on the automatic compression of the air from the turning of the wagon wheels are efficient when the trees are small and can be rapidly sprayed. They are failures among large trees that require some minutes to spray before any advance is made. Neither of these types has adequate agitation equipment and other means must be employed wherever necessary to keep the material well mixed.

Carbonic Acid Gas Pumps

The working principle of carbonic acid gas pumps is almost identically like the compressed air type, except that the cylinder is charged with carbonic acid gas instead of air. It is an efficient, serviceable pump, but with respect to the agitator it is equally as inefficient as the compressed air pumps.

Spraying Accessories

No pump, no matter how capable, will give service without the complementary support of good spraying auxiliaries of the best quality and design. As much attention should be given to these as to the pump itself. These accessories consist of hose, extension rod, stop cocks and nozzles.

Hose

Nothing need be said of this save that it should be of the best quality and ample length. As a matter of economy, it is cheaper to buy the best grade of four-ply goods. This will easily last a full season or longer with proper care. Cheaper grades are quick to leak and are generally unsatisfactory. The better grades of hose cannot be bought for less than fifteen cents per foot.

Extension Rods

No spraying outfit is complete without an extension rod. It is an indispensable adjunct in reaching to all parts of the trees, expediting the work and improving the quality of the spraying. Besides these advantages, it is a protection to the operator, enabling him to evade a wetting from the spray mist as it is blown or drifted about. Rods are usually made of 1-4-inch piping and are cut to any desired length based upon the requirements. Bamboo rods are also used for the same purpose. Piping may be cut in short lengths and lengthened or shortened at will to suit the occasion by means of couplings.

Stop Cocks

Stop cocks are very serviceable and almost imperatively necessary in large spraying operations. By cutting off the flow they prevent waste in moving from tree to tree and are invaluable to successful and economical spraying. There are only a few types, the best of which is the brass stop cock with stuffing box that may be tightened so as to prevent all leakage. This type has a cut-off handle two inches long extending on just one side of the stuffing box and readily cut on or off by the thumb.

Nozzles

There are nozzles of all kinds and sizes and one must be governed by the requirements in each case. In spraying for scale insects it is of prime importance to use only nozzles throwing a finely divided spray. Maximum good results are obtained from nozzles insuring this important feature.

The best types of nozzles used in Georgia are the Vermorel, Bean, Friend, and Mistry, Jr. These may be attached to the rod singly, in couples, or sets of three or more. In the writer's opinion the best nozzle now on the market is what is called the Mistry, Jr. The Bean Manufacturing Company also make similar nozzles. In this type the construction is exceedingly simple; they do not easily become clogged and are readily cleaned when the flow becomes obstructed. They are without the degorger common to the Vermorel type and the objectionable features occasioned by the catching of these prongs on the limbs, pulling off the fruit, etc., are eliminated. Their extreme simplicity, the ease with which they are cleaned and the rapid and thorough work they insure puts them well at the head of the list in the world of nozzles.

PRESIDENT SANDERSON: These three papers open up a wide field for discussion.

MR. SYMONS: I would say that I feel some hesitation about discussing this problem beside Mr. Worthley, who has so ably presented the matter of spraying in the New England States. He gives some good reasons why the price of rubber has gone up. We hear of the miles of hose they have used. There are some points I glean from these papers, with which I do not entirely agree, but on the whole they are very instructive. Referring to the point made in regard to the use of the barrel pump, and a man maintaining two leads of hose, I would say I would not like to be the man to keep the nozzles busy. There is another point, I note that two of the papers do not advise the use of gear sprayers. We have found in our state that in some respects gear sprayers have given considerable satisfaction. It certainly is to be said they are not designed for treating large trees. We previously had a gasoline engine made in accordance with our own ideas, and the men have absolutely abandoned that engine for the Brown gear sprayer. Now, in regard to the sprayers on the market, it seems to me the manufacturers have been slow to take up some points we have made in regard to spraying machinery. I know at least one firm which continues to make pumps with large air chambers above the barrel, which I believe we all concede is rather impractical. Moreover, the power sprayer is the coming sprayer, and of that kind I would say the Friend seems to be predominant. But, even with that outfit, I believe that they can reduce the weight of the engine. The one we previously used weighed only ninety pounds, and gave satisfaction, while the larger engines, the Goulds and others, weigh from 300 to 400 pounds, and certainly it seems as if they could reduce that weight. I think the suggestion made by Professor Ball in regard to a tower is an excellent one.

MR. HEADLEE: Our time is very short, and I think the ground has been thoroughly covered. I wish to touch briefly on one point—spraying by means of compressed air. In large orchards compressed air appears to be one of the very best sources of power. Mr. George Richardson of Tonganoxie, Kan., has gotten together the necessary machinery and has used compressed air for several years in treating his large orchard. He said to me at Christmas time, "If I did my spraying as most fruit growers do it, I would have to have four or five expert engineers, and that would mean a large expenditure of money. As it is now, I have one capable engineer and a good air compressor, and I keep my three wagons going all the time." He claims to spray 8,000 to 10,000 gallons a day. His apparatus, including the plant for making lime-sulphur wash, represents an investment of about

$3,000. I happen to know that he never stops to spray a tree, but goes straight along. He has the men on platforms on the side of the wagon, and the wagon starts right off down between the rows, throwing the spray in a perfect cloud as it goes. As soon as the tank is empty, the next wagon comes up with its full tank, and connections are immediately made. The liquid is agitated by delivering compressed air at the bottom of the tank, and a precipitate is never found in the emptied tanks.

SECRETARY BURGESS: The power sprayers on the market are assembled, that is, they are not built by one firm, and as a rule, the pumps are made for other purposes than spraying. The engines are also built for other purposes. Most of them are heavy stationary engines, which are simply hooked up with some pump. It seems to me that what is really needed is a spraying machine that is built for the purpose of spraying, rather than spraying machines that are built by assembling various parts—pumps, engines, etc.—which have been designed for other purposes. Professor Symons mentioned the idea of spraying from a tower. I believe the time is coming when we will give the fruit grower an equipment so that he can spray from no higher point than the top of the tank, or from the ground. I believe the system of solid stream spraying, properly adapted—it must be worked out and experimented with—can be used in any orchard, and the operator can spray from the ground.

MR. SYMONS: Those who spray for truck crops say that the Hillman sprayer has been found very satisfactory. It has a double acting pump which can be used for spraying trees if desired. There are several other satisfactory ones on the market.

PRESIDENT SANDERSON: I think it is very evident that we could spend more time on this subject. No one has mentioned the use of the gasoline engine with compressed air. It is very evident to all of us that what Mr. Burgess has said about the attitude of pump companies is very true. The insecticide companies have gone away in advance of the pump companies. I would like to suggest that when this symposium is published, it might be a good idea to send a marked copy to each of the pump companies. The next paper will be read by Mr. Webster.

SPRAYING WITH LINSEED OIL WASH FOR THE OYSTER-SHELL SCALE

By R. L. Webster

At the Boston meeting of this association Prof. R. A. Cooley read a paper giving the results of tests of several spray materials for the oyster-shell scale. One of the most promising of these was a linseed oil emulsion. The writer has been trying a number of materials against this scale in Iowa, but with no success, and so this linseed oil wash was given a trial last spring.

Professor Cooley's formula, which I used, is given herewith:

Hard soap	1 pound
Raw linseed oil	1 gallon
Water to make	12 gallons

The soap was dissolved in a small quantity of water and an emulsion was made with the oil. This was diluted while warm to the required strength.

The mixture was used during the hatching period of the insect, which was long drawn out last spring. One spraying was made May 13 and another May 18, in a badly infested orchard at Ames. Both sprayings were very effective; far better than the lime-sulphur wash or any other mixture that I have tried.

The linseed oil wash adhered to the trees very well. It was still conspicuous as late as July 22. There was no injury to the leaves; in fact, the foliage was in excellent condition all summer. The season was exceptionally dry.

The young scale insects were plentiful on the trees when they were sprayed. The spray evidently killed most of the young which had settled down and it also prevented others from establishing themselves on the bark. Very few live insects were found on the sprayed trees later in the season. The earlier spraying, that of May 13, seemed to be slightly more effective than the later one.

From time to time unsprayed trees in an orchard just across a railroad track were compared with the sprayed trees. The unsprayed trees were badly infested, like the sprayed trees. Living scales were very numerous during the late spring and summer on the unsprayed trees, while a live scale was found only here and there on the sprayed trees.

The cost of this linseed oil wash is a serious drawback on its use. Raw linseed oil has been quoted to me F. O. B. Des Moines at $1 a gallon in 10-gallon lots, or 97 cents a gallon in 50 or 100-gallon lots. At this rate the mixture would cost about nine cents a gallon.

PRES. SANDERSON. The next paper will be read by Mr Symons.

THE TERRAPIN SCALE IN MARYLAND

By T. B. SYMONS and E. N. CORY, *College Park, Md.*

[Withdrawn for publication elsewhere.]

PRESIDENT SANDERSON: Is there any discussion?

MR. SMITH: I was interested in Professor Symons' paper. We had that scale in one of our counties. It is the only county in the state of New Jersey where it has done great injury to the trees, more than in Maryland. It has a tendency to kill the twigs, and so very largely causes the loss of fruit. I found we could prevent this habit of going out on the twigs by pruning, and we have advised pruning to good effect in some instances. Professor Symons said definitely that he had no success with lime-sulphur, which I knew before, as we had not had in our state. He also said he used miscible oils in the fall, and in the spring he used scalecide. We used this, but not so strong as Professor Symons did, on one man's trees. He said the conditions were so bad that he was willing to do almost anything to save his trees. I advised him to use crude oil, with the understanding that it was a kill or cure remedy.

PRESIDENT SANDERSON: I would say I have omitted two papers by Professor Gossard. Possibly we could hear from Professor Gossard now.

ENTOMOLOGICAL REVIEW OF THE YEAR 1910

By H. A. GOSSARD, *Wooster, Ohio*

From the observations of our staff and the correspondence of the year I have selected the following notes as possessing sufficient interest to report for publication:

Among our field tests scalecide was tried in both fall and spring applications compared with commercial lime-sulfur and also with home-made concentrated lime-sulfur made according to the formula given by the Pennsylvania Experiment Station. About 20 acres of young apple orchard with bearing peach trees for fillers were subjected to this comparative test. All of these applications were practically effective against San José scale, leaving scarcely any survivors at all. So far as it was possible to discover any distinctions at all between the results of the different treatments, there appeared to be a few more scales on the oil sprayed trees than on those treated with the lime-sulfur mixtures, but from a practical standpoint all the results

were satisfactory and to cursory observation almost indistinguishable. Part of the home-made concentrated lime-sulfur was kept over winter and used in the spring. Some sediment formed in this home-made concentrated product and we were not able to satisfy ourselves that it would in all cases be equal to the commercial brands, although our result from the field test seemed quite satisfactory.

We used lime-sulfur and arsenate of lead combined for spraying apples and obtained more satisfactory results with this mixture than with arsenate of lead combined with bordeaux or with bordeaux to which sulfate of iron had been added. Seven orchards aggregating about one hundred and forty acres in extent and located in different quarters of the state were employed in these tests. The results on both foliage and fruit with the lime-sulfur mixtures were superior to those obtained with the other combinations, but were not perfect by any means in some respects. For instance, we russeted the fruit very noticeably on some varieties, though not so badly as with the other sprays. That variety influences the result with this spray exactly as it does when bordeaux is used seems proved to us by the difference noticed in the apples in our variety orchard at the experiment station. Trees of different varieties standing in the same row and sprayed from the same tankful of material and only a few minutes apart, would exhibit all gradations of russeting from perfect skins without suspicion of a blemish to cracked and distorted fruit that could easily serve as illustrations of bordeaux injury. But the aggregate of damage was much less than where bordeaux was used in the same orchard, and the foliage was in all respects better. The horticultural department of the station gathered the notes on these varietal results. In southern Ohio three sprayings with lime-sulfur, once before bloom, just as the buds were beginning to show pink, a second time in combination with arsenate of lead just after bloom, and a third time in late July, failed to satisfactorily control the leaf-spot or frog-eye fungus (*Sphæropsis malorum* and *Coniothyrium pirini*) though results were better than with bordeaux. An inspection made in early June showed a wonderful difference in favor of the lime-sulfur as compared with bordeaux, but later developments more nearly balanced the comparison. A late freeze destroyed all of the fruit on this orchard and we obtained results on foliage alone. Commercial lime-sulfur was used in all of these tests. The degree of dilution was about one to thirty, and was reduced to uniform strength for the tests by hydrometer determinations.

We used self-boiled lime-sulfur combined with arsenate of lead on peaches, plums and cherries, using an orchard of about five acres each of plums and peaches, and about one-half acre of cherries, the

latter containing both sweet and sour varieties. The plums were sprayed as soon as the petals were down and the fruit well set, the cherries soon after the falling of the bloom, but not till the fruit was as large as peas, and on the peaches we made the applications practically as directed by Professors Quaintance and Scott in Circular 120 of the Bureau of Entomology. A second application was given to the plums and peaches about four weeks after the first, and a third was given to some of them in late July. For comparison a block of each sort of fruit represented: viz., peaches, plums and cherries, was sprayed with bordeaux mixture combined with arsenate of lead, and others with bordeaux plus iron sulfate and arsenate of lead. The commercial lime-sulfur diluted with 100 parts of water and combined with arsenate of lead was also applied to small plots of each of these three kinds of fruit. The superiority of the self-boiled lime-sulfur over the other mixtures was very apparent as regards both foliage and fruit. What with the dry season and the spraying together, almost no brown rot appeared, very little curculio developed and the crop was the best, on the whole, ever harvested from the orchard. The results with the commercial lime-sulfur with the dilution tried were fairly satisfactory, more so than with the other materials except the self-boiled wash. One striking incidental result was the effect of the lime-sulfur wash on aphids in these orchards. So striking was the contrast between the trees sprayed with this material and those sprayed with bordeaux that strangers would stop to inquire why certain trees were so lousy while their neighbors in the adjoining row were so clean. A difference in this regard was likewise noted in the apple orchards under treatment, and it seems to me that we have good grounds for hoping that with the general adoption of this spray, the woolly aphis and its attendant diseases of blight, canker and collar rot will become much less prevalent. This insect was unusually bad over all Ohio last season, attracting far more notice from orchardists than in any year of the last six. We found the young of both the scurfy scale and the oyster-shell scale appearing at just about the time for making the first spraying for codling worm, and hope the lime-sulfur used at this time as a fungicide will also greatly reduce the numbers of these. Owing to the early season in Ohio we thought possibly San José scale would appear a little earlier than usual, but so far as we were able to determine from observations at Wooster, and from samples reaching us in the ordinary course of mail, the young began to appear at the usual time, or about the middle of June in northern Ohio.

We have continued our experiments with bark beetles in northern Ohio along the lines which seemed from the preceding two years' experience to promise most. In a few cases trees that had been white-

washed were badly attacked, but our previous recommendation that three whitewashings be given per year, one in March or April, a second in July and a third in late September or early October, seems to hold good on the average, and we feel confident that this program of treatment, if carefully adhered to and the work is thoroughly done, will control these pests, provided cultivation, pruning and fertilizing are intelligently combined with it. There is no doubt that the 12 per cent emulsion of carbolineum avenarius is more effective in controlling the beetles, but we have not always had entirely satisfactory results upon the trees following its use. On the 2d of June Mr. Whitmarsh found adults of *Monarthrum fasciatum* appearing in great numbers upon two peach trees near Danbury, Ohio, the trees having been fairly riddled by them. He was not able to locate the species elsewhere. We have not been able to find any previous record of this species attacking peach. The Red Shouldered Sinoxylon, *S. basilare*, in peach wood was received from a correspondent.

We tested the properties of iron oxide which had been used for purifying gas and thrown out as a refuse product from the gas factory, as a remedy for white grubs. Five or six acres of land was subjected to test and several tons of oxide were used. It was applied at the rate of 3,000 pounds per acre, 4,000 pounds per acre and 6,000 pounds per acre, or rather the fertilizer drill was set to sow fertilizer at these rates. The oxide did not feed so fast as fertilizer and the actual weights applied were about 66 per cent of these figures. On one of the potato patches this was applied about one month before planting time and the land was thoroughly disked and cross-disked to evenly distribute the oxide through the soil. An extra harrowing was given later to prevent weeds from starting. On most of the plots no difference could be detected in the results, the checks appearing in all respects like the treated plots. Growth was apparently interfered with on the plots receiving the heaviest applications and the stand of plants on these was noticeably thinner than over the rest of the field. The material was applied to one field just before planting and the stand in this field was perceptibly reduced. Living grubs could be found in the treated blocks long after the treatment was given and so far as we were able to ascertain they were scarcely interfered with at all. If the grubs had been more abundant it is possible that results would have been more apparent, but we hardly anticipate great results from this treatment. Grubs have elicited many inquiries at the Ohio station during the past three years. We made one test to determine the comparative merits of arsenate of lead and of powdered arsenate of iron when used for the Colorado potato beetle. Both poisons were applied in combination with bordeaux. A double appli-

cation was made with a Spramotor field sprayer and the beetles were practically annihilated by both poisons, but it required several days longer for the iron compound to fully accomplish its work than the lead poison.

In Paulding County considerable damage was done to young corn by the very common crambid webworm, *Crambus trisectus*. A number of fields had to be replanted and the stand in many others was greatly thinned. Except this species, I could find only a single caterpillar of *Crambus caliginosellus* concerned in the damage. Where corn had followed corn, there was no damage, but over pasture lands and stubble fields of the preceding year, the worms were abundant, as many as a dozen being quite readily found in some hills of corn. I found the worms feeding freely about the roots of clover and proved by observation that they could readily subsist on this plant without other food. The farmers reported that some of their Indiana neighbors had some success in controlling the worms by the use of a fertilizer attachment to the corn planter by which a quantity of tobacco dust was dropped in each hill. We had no opportunity to test the remedy. Grasshoppers were reported as more than usually destructive and numerous from several points in northwestern Ohio and from one locality in the southeastern part of the state. In northwestern Ohio chinch bugs have been more numerous the past season than for many years, and considerable damage was done to corn after wheat harvest. We distributed many packages of *Sporotrichum globuliferum*, but our cultures seemed to lack virility even under favorable conditions, and I question if we were not doing more harm than good by distributing it, for many farmers will rely altogether upon it and do nothing at all for themselves if the fungus is supplied to them. The wheat joint worm was less numerous than for three years, but was responsible for a good deal of damage. The Hessian fly was more numerous in the fall than for several years and we anticipate general and quite severe damage from it next season. We put out a press bulletin in early September advising rather late sowing, but would have been considerably more emphatic if we had sensed the full situation. The general and prolonged drought in many sections of the state retarded the appearance of the flies, and the copious rains of early October brought out all the stragglers with a rush and massed them at a date so late that even very late sown wheat was severely attacked in many instances. Our records at the station show that egg-laying had been under way and at quite a vigorous rate previous to the 19th of September, and continued throughout the month, reaching a maximum for the last eleven days of the month on the 26th and 27th. On the 8th of October, following three or four days of drenching

rain, eggs were being laid at the most rapid rate of the season. But few eggs were laid after this date at Wooster, though scattering ones could be found deposited daily until the 16th to the 20th of October. On the 13th of October I examined 143 plants taken at random from numerous points over the station wheat plots sown September 26 and 27. Of these, sixty-seven plants were clean and seventy-six of them had a total of 212 eggs on them, or 53 per cent of these late sown plants had on them an average of about three eggs each. Since many of these will perish before spring, even in case all hatch, we think this wheat safe, but evidently we are in more danger from this insect than we have been since 1900.

The plum gall mite is apparently on the increase in the state and each year we receive a few more reports from new localities than we did the preceding year.

The clover or pea louse, *Macrosiphum pisi*, became abundant in early summer, especially in northwestern Ohio and some fields died out after the clover was cut. Droughty conditions, undoubtedly, had much to do with its unusual abundance. The clover thrips also caused more inquiry than usual. The clover seed chalcis, which was extremely abundant for one or two seasons preceding the present, caused very little trouble this year, or at least it was not sent to us in sufficient numbers to attract our attention.

I saw one very interesting result of the use of formalin solution on onion seed at planting time. So successful was the mixture in preventing smut and giving the plants a vigorous start by which they were enabled to outgrow damage by root maggots, that some of the growers were inclined to think it possessed both fertilizing and insecticidal properties. It appeared to me to be of more value in enabling the plants to out-strip maggot damage than fertilizer applications would be. Our animal husbandman requested a formula for the destruction of flies at the hog barns. I recommended a solution of formalin and water, but he reported that he obtained little success with it until he used it in combination with sour milk and swill. After using it in this way, he was soon able to sweep bushels of dead flies from the floors. The catalpa midge continues to be the worst enemy of catalpa plantations. One of our correspondents sent us the common Carabid beetle, *Galerita janus*, with the report that he had more than once found it feeding voraciously on the young of the Colorado potato beetle. We caged the species with an abundance of young potato bugs, but were not able to verify the observation. The birch borer, *Agrilus anxius*, is causing much destruction to birch trees in the parks of Cleveland and Toledo. The corn pollen maggot, *Mesogramma politum*, has been reported from Newark for two successive

seasons by the same party as causing severe damage to his sugar corn. The clover hay-worm was reported from two parties as destructive to alfalfa in mows. The bumble flower beetle, *Euphoria inda*, was reported from several localities as unusually injurious to corn in the silk. *Euphoria sepulchralis* was also received once or twice with a similar accusation against it, or rather was included among the samples of *Euphoria inda*. The mealy flata, *Ormenis pruinosa*, and the green flata, *Chlorochara conica*, were both received in a sending of insects said to be exceedingly destructive to ginseng. The red-humped caterpillar of the apple was more than usually prevalent throughout the state as was also the oblique banded leaf-roller. The raspberry Byturus has been injurious locally, here and there exceedingly so, but its distribution in destructive numbers seems to be very restricted. The grape-berry worm has caused comparatively little damage and can scarcely be found in some of the neighborhood where it was so abundant a few years ago. The linden tree louse, *Lachnus longistigma*, was very abundant in Cleveland for the past two seasons rivaling its record in Washington city for 1889. The maple sesian, *S. acerni*, has been very injurious to maple trees for two or three seasons.

The potato scab gnat, *Epidapus scabei*, was located in a potato patch just in the outskirts of Cleveland. It was quite destructive; so much so that a request was filed with us for an investigation, and this led to its discovery. No seed had been imported onto the place for several years, from which we were obliged to infer that it was indigenous to the locality.

In the latter part of August, we received from Shandan, Ohio, the tenebrionid beetle, *Platydema ruficorne*, working in stored corn. They hollow out the grains while on the cob, and seem to possess all the capabilities for damage which characterizes a number of other pests in the same family. So far as we have been able to determine, nothing has been published hitherto regarding the life-history and habits of this beetle.

PRESIDENT SANDERSON: Is there any further business before we adjourn?

MR. WASHBURN: You were kind enough to include me in the mention of thanks for the entertainment here. The work at the Agricultural College has been done by my assistants, Messrs. Ruggles, Urbahns, and Stafford, and whatever thanks you offer are due in part to them.

There being no further business the meeting adjourned.

A. F. BURGESS, *Secretary*.

[The following papers were read by title.]

NOTES ON THE LIFE HISTORY AND HABITS OF PEGOMYA BRASSICAE

By W. J. SCHOENE

Late cabbage is one of the important farm crops in many sections of western New York. In general the crop is profitable. It grows vigorously and thrives on many types of soils, and will usually make a crop even when conditions are somewhat unfavorable. The greatest obstacle to the successful culture of late cabbage is the cabbage maggot, *Pegomya brassicæ*, which attacks the plants while they are in the seed bed. The insects are so abundant some seasons that farmers are not able to grow sufficient seedlings for their plantings. Different methods have been adopted by the farmers to cope with the problem but in general they have not been successful. In taking up this problem it was apparent that no progress could be made in protecting seed beds until there was more definite data regarding the life history of the cabbage maggot, especially the period of oviposition of the first brood of adults. This insect has received attention for three seasons and it is desired to present some of the results of this study.

Oviposition of the First Brood of Flies

To determine accurately the period during which the bulk of the eggs are deposited was an important part of the problem. The observations recorded in Table I were made by examining each day, or twice every three or four days a varying number of plants grown in the open field. The usual procedure was to remove the eggs and soil from a number of plants and add other soil containing no eggs. After an interval of a few hours the same plants were examined and the number of eggs noted. The data presented is intended to show the period of greatest abundance. It is probable that our notes do not show the first eggs deposited and it is quite certain that a few eggs were deposited throughout the month of June.

The Number of Days from Egg Deposition to Appearance of Adults

Believing that the widely divergent periods mentioned by various workers for the pupal period were unnatural, and that the insects under observation had been unduly influenced by laboratory conditions, the following experiment was planned in order to place the insects as nearly as possible under the same conditions as those in the field. In 1909 a number of 8-inch flower pots were filled with sterilized earth and in each were planted cabbage plants that had been grown in the greenhouse. Before transplanting, the plants were

TABLE I

PERIODS OF MAXIMUM EGG DEPOSITION BY FIRST BROOD OF ADULTS DURING 1908–09–10

Date	1908	1909	1910
May 10	.....	.....	.....
12	.....	.....	.....
14	.....	.....	.....
15	Very few	.....	Very few
16	.....	Very few	.....
17	.....	.....	Few eggs
18	.....	Few eggs	.....
19	.....	.....	.....
20	.....	.....	.....
21	Abundant	Abundant	Very abundant
22	.....	.....	Very abundant
23	.....	.....	Abundant
24	Abundant	Few	.....
25	Abundant	.....	.....
26	.....	.....	.....
27	.....	.....	.....
28	.....	Very few	.....
29	Very abundant	.....	.....
30	.....	.....	.....
31	Abundant	Very abundant	Abundant
June 1	Very few eggs	Very abundant	Abundant
2	More numerous	.....	.....
3	Abundant	.....	.....
4	.....	Abundant	.....
5	Abundant	.....	A few eggs
6	Few eggs	.....	.....
7	.....	.....	.....
8	.....	.....	.....
9	Very few	.....	No eggs
10	.....	Not so numerous	.....
11	.....	No eggs	.....

carefully examined to insure their freedom from eggs and maggots. The pots were then covered with cheese cloth to avoid parasites and reinfestation. In 1910 the work was repeated in the same manner, except that a modification of the "Tower" cage was used instead of the pots. Eggs were then placed on the soil close to the plants. With the exception of renewing the food in some of the breeding cages of 1909, the insects upon hatching were permitted to feed, pupate and emerge without interference. Both seasons the cages were sunk in the soil, and it is believed that the moisture and temperature conditions were about the same as in the surrounding earth.

In 1909 only twenty-three adults were bred from eleven breeding pots, the small number being due possibly to dry weather and insufficient food. The period from egg deposition to appearance of adults ranged from twenty-seven to sixty-one days, with an average of forty-three days. Eighty-two per cent of the individuals emerged within forty-five days.

The record for 1910 is shown in the following table:

TABLE II

RECORDS OF THE NUMBER OF DAYS FROM EGG DEPOSITION TO APPEARANCE OF ADULTS, IN BREEDING CAGES, AT GENEVA, N. Y., DURING 1910

Eggs deposited May 15, 1910			Eggs deposited May 17, 1910			Eggs deposited May 23, 1910			Eggs deposited June 5, 1910		
Date flies emerged	No. of flies	No. Days	Date flies emerged	No. of flies	No. Days	Date flies emerged	No. of flies	No. days	Date flies emerged	No. of flies	No. days
June 20	2	36	June 22	1	36	July 2	4	40	July 9	3	34
21	2	37	23	1	37	3	5	41	10	3	35
25	2	41	July 1	2	45	4	2	42	14	1	39
27	1	43	4	1	48	5	2	43	29	2	54
July 18	1	64	5	1	49	6	6	44	Aug. 13	2	69
Aug. 10	1	87	6	1	50	7	2	45	15	2	71
.....			27	1	71	8	2	46	16	1	72
.....			Aug. 13	4	88	17	1	55	17	2	73
.....			.....			27	3	65	.....		
.....			.....			Aug. 13	4	82	.....		
.....			.....			16	2	85	.....		
.....			.....			17	4	86	.....		

The extent of time from the laying of the eggs to the appearance of the adults, ranged from thirty-four to eighty-eight days, with an average of fifty-five days. Fifty-four per cent of the adults emerged within forty-five days.

Larval Stages and Number of Days Required for the Larva to Mature

Efforts to breed the insect in the laboratory and to observe the larval ecdyses have not met with success. Some cast-skins were secured, but not with sufficient regularity as to be certain of the stages. The data given below in Table III was secured by growing in the laboratory a number of larvæ which were hatched the same day. Each succeeding day several of these were killed and preserved. By this means a series of larvæ were obtained which ranged in age from one to eighteen days. One or more larvæ of each lot was measured and the cephalo-pharyngeal skeleton mounted in balsam. A study of the chitinous structures indicate three well-marked stages for the

Fig. 5. Relative sizes of cephalo-pharyngeal structures of 1st, 2d and 3d stages of larva of *Pegomya brassicæ*. Camera lucida drawings x 65. (Original.)

larvæ. These instars may be known by the difference in the size and shape of the cephalo-pharyngeal structures. The increase in size of the different individuals of the series was not proportional to the age. In some instances larvæ of the same age would vary so in size that one would be three times as large as the others. These variations did not appear in the chitinous structures of these individuals. Aside from the differences in size which mark the three stages, there is a thickening or blackening of the chitin which becomes very pronounced in the older larvæ. Thus the amount of pigment, together with the size of the skeletal parts would indicate the age of the larvæ more closely than the dimensions of the individual.

In the examination of the larvæ previous to the separation of the chitinous structures, it was noted that all the larvæ possessed the bifed caudal tubercles ascribed to *brassicæ* by Fitch in his eleventh report.

TABLE III

COMPARATIVE MEASUREMENTS OF THE CEPHALO-PHARYNGEAL STRUCTURES AND OF THE SIZE OF THE LARVÆ

Age of larvæ in days	Length of dorsal sclerite of cephalo-pharyngeal skeleton	Length of larvæ	Diameter of larvæ
1	136 microns	1.25 mm.	.....
2	136 "	1.75 "	.....
3	289 "	1.75 "	.....
4	323 "	1.75 "	.....
6	340 "	3.25 "	.....
7	329 "	3.75 "	.....
8	314 "	3.75 "	.....
9	612 "	5.50 "	.....
11 A	527 "	5.50 "	1.50 mm.
11 B	612 "	2.50 "	1.00 "
13	535 "	4.50 "	1.50 "
14	612 "	4.50 "	1.25 "
15	561 "	5.50 "	1.50 "
16	586 "	7.00 "	1.75 "
17	612 "	5.50 "	2.00 "
18	612 "	6.50 "	1.75 "

Aërial Habits of the Larva

The question of removing the stumps from the field after the cabbage crop has been harvested has frequently been discussed by entomologists. The advisability of such a procedure depends upon the numbers of injurious insects that would be killed or avoided. To obtain data on this point a number of fields were inspected in this locality and on Long Island.

The stumps examined, and especially those from which "early" cabbage had been cut, were found to contain maggots. Some of these were feeding upon the root, but the majority of them were found in the upper part of the stalk, at the base of the leaves and in the cortex of the adventitious buds. The maggot has generally been considered a subterranean insect, and little mention seems to have been made to an aërial habit. The fact that in some fields a large percentage of the larvæ work in the top part of the plant during September and October is thought important because of the possibilities of reducing the numbers of these insects by the timely removal of these crop remnants. Adults and eggs have been observed in considerable numbers about

Injuries by cabbage maggot in principal portion of cabbage stump.

these adventitious buds, and their presence is partly understood because of the great numbers of these buds or sprouts that appear after the cabbage is cut. It is probable that the adults are attracted to the "sprouts" because of the tender growth. Rough estimations, based on the examination of 50 to 100 plants in each of a number of fields indicate from 300 to 1,500 maggots per acre.

Effect of Plowing on Pupæ

For this experiment a seed-bed badly infested with maggots was selected. The injury to the roots of the plants in this bed was so general that the entire planting was abandoned by the owner. The soil was very light and sandy, and the plot on which the bed was located had just enough slope to carry off the surface water. Two portions of the bed in which the injuries seemed equal were chosen, and on June 23d one was plowed to the depth of six or seven inches and harrowed. The next day a small cheese-cloth screen 6 x 24 feet, such as is used in this locality for the protection of seedling cabbages, was erected over each part. (Bul. 301, N. Y. Sta.) As the flies emerged from the soil they were collected, the dates and numbers taken being as follows:

TABLE IV

THE DATES OF APPEARANCE AND NUMBER OF FLIES COLLECTED FROM PLOWED AND UNPLOWED SOIL AT SENECA CASTLE, N. Y., DURING 1909

Date	Unplowed	Plowed
June 29	141	51
July 1	193	21
3	170[1]	28
5	151	24
7	74	16
9	47	20
13	8	26
17	36	35
21	18	4
26	15	0
30	11	5
Total	864[2]	230[2]

As shown in the above table only about 27 per cent as many flies emerged from the plowed as from the unplowed plot.

[1] Numbers estimated.

[2] About 10 per cent of the males in these collections were *P. fusciceps*.

The difference in the numbers collected from the two plots was so apparent, from the first, that a yard of the soil adjacent to each of the screened beds was sifted to determine the relative position of the pupæ in the plowed and the unplowed soil. The first and second three inches of soil were sifted separately. The numbers of pupæ found are recorded in the following table.

TABLE V

EFFECTS OF PLOWING ON DEPTH OF PUPÆ IN THE SOIL

	Number of pupæ in first 3 inches	Number of pupæ in second 3 inches	Total	Per cent of pupæ in first 3 inches
Unplowed soil..	74	5	79	93
Plowed soil.....	19	32	51	37

It should be noted that in the square yard of plowed soil only 37.2 per cent of the pupæ were found in the first three inches, while in the unplowed plot 93 per cent were found in the first three inches.

It seems hardly possible that the facts as presented could be accounted for, other than the direct effect of cultivation. Prior to this experiment the two plots were covered with seedlings at the rate of 200 or more per square yard and these were either killed or their roots so badly injured that they were unfit for use. For this reason it is thought that the numbers of pupæ in the two plots must have been approximately equal before the ground was plowed.

OVIPOSITION AMONG TREE-CRICKETS

By P. J. Parrott

In the Journal of Economic Entomology, Vol. 2, pp. 124–127, a brief account was given of the work of *Oecanthus niveus* De Geer on apples, and *O. nigricornis* Walker on raspberries. The present paper deals with observations on the egg-laying habits of these species and of *O. quadripunctatus* Beut. The crickets on which these studies were made were captured in the same raspberry planting, and single pairs of each species were confined in breeding cages in which were growing both apples and raspberries. The number under observation were ten pairs of *niveus*, six pairs of *nigricornis* and four pairs of *quadripunctatus*.

Egg Deposition in Apples and Raspberries

Recent studies have shown that *niveus* deposits its eggs in the bark of apple, plum and peach trees. Elms, willows and other trees are

also probably frequented for purposes of oviposition. The common occurrence of adults in raspberry plantations has raised the question if the species really oviposits in raspberry canes. Repeated examinations of vines in one planting have tended to cast doubt as to such a habit, and the evidence indicates that the cricket prefers other plants for the deposition of its eggs. When apples and raspberries were grown together in the same cage *niveus* invariably laid its eggs in apples, but in the absence of other plants it would deposit eggs in raspberries. *Nigricornis* and *quadripunctatus* always preferred raspberries, but when it had no alternative, *nigricornis* sometimes laid eggs in apple wood, usually selecting the tips of the new growth.

Process of Egg Deposition

In brief, the process is as follows: The female, having selected a suitable spot on the plant, first gnaws a hole in the bark. She then advances forward, and moving the ovipositor at right angles to her body, she inserts the tip of it in the wound and proceeds to bore the hole for the reception of the egg. The drilling is accomplished by a thrusting and rotating motion of the ovipositor. After boring to a suitable depth the egg is deposited. An adhesive substance is then discharged which is kneaded about the egg by the ovipositor; then withdrawing this organ, she reverses her position and completes the process by capping the opening with small particles of bark, which are held firmly in place by the mucilaginous substance surrounding the egg.

The actual time consumed in the process of egg deposition varies apparently with the species. The period of laying an egg also differs in extent with individuals of the same species. In ovipositing in apple wood of an inch and a half in diameter, adult females of *niveus* spent from seven to sixteen minutes in gnawing a cavity in the bark, from twenty-seven to seventy-six minutes in drilling with the ovipositor, and from three to five minutes in depositing and disguising the egg. The eggs are laid singly, and if the female is not disturbed as many as four eggs may be deposited in the neighborhood of each other during one night.

In depositing their eggs in raspberries females of *nigricornis* spent much less time in the various operations. From twelve to seventeen minutes were occupied in boring the hole with the ovipositor, and from five to eleven minutes in laying and disguising the egg and in gnawing an opening preparatory to drilling. As the preparation of a niche for the egg in raspberry canes by *nigricornis* is more rapidly accomplished than by *niveus* in apple wood, so the number of eggs

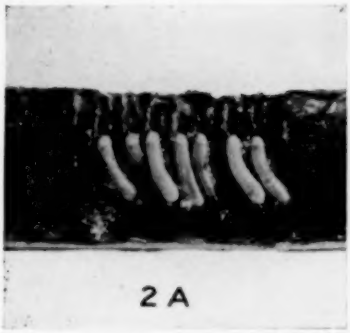
deposited in the same interval of time by the former will usually be higher than that of the latter. A female of *nigricornis* was observed to lay seventeen eggs in a cane during one night, which greatly exceeded the number deposited in the same time in apple wood by *niveus*. The eggs of *nigricornis* were laid in linear series. The number of eggs in a row are variable. Of twenty-five egg masses selected at random, the number ranged from one to eighty-one, giving an average of thirty eggs to a row. The number of eggs in a series is sometimes increased by several ovipositions at varying intervals by the same female.

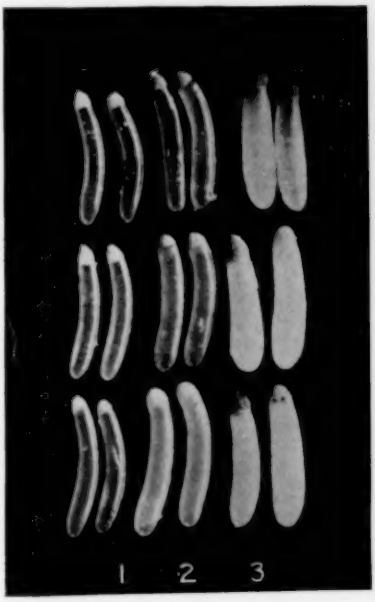
The females of *quadripunctatus* in breeding cages deposited their eggs in rows similar to *nigricornis* in the petioles of the leaves. The injuries to the plant are not so extensive as with the latter species, and the scars are therefore much less conspicuous.

The oviposition period and the numbers of eggs deposited by the females of the three species are as follows:

OVIPOSITION PERIOD AND NUMBER OF EGGS DEPOSITED BY INDIVIDUAL TREE CRICKETS

Species	Oviposition period	Total number of eggs
niveus 1	Sept. 8 to Sept. 26	67
" 2	2 26	27
" 3	8 29	19
" 4	5 23	23
" 5	7 13	5
" 6	8 12	6
" 7	5 14	10
" 8	7 12	3
" 9	7 14	14
" 10	7 14	28
nigricornis 1	Aug. 29 to Oct. 1	165
" 2	Sept. 2 to Sept. 16	64
" 3	Aug. 30 to Sept. 3	26
" 4	Sept. 2 to Sept. 26	78
" 5	Aug. 29 to Sept. 6	52
" 6	Aug. 26 to Sept. 22	31
quadripunctatus 1	Sept. 8	18
" 2	Sept. 2 to Sept. 22	15
" 3	Aug. 29 to Sept. 26	40
" 4	Sept. 2	17





Oviposition among tree crickets: 1, Eggs of *quadripunctatus* Beutm.; 2, Eggs of *nigricornis* Walk.; 2a, In raspberry cane; 3, Eggs of *niveus* DeGeer; 3a, Punctures by *niveus* in apple bark; 3b, bark removed showing egg in position.

THE CABBAGE APHIS, APHIS BRASSICAE

By GLENN W. HERRICK

Mr. J. W. Hungate, a graduate student in entomology at Cornell University, made a careful study of the habits and life history of the cabbage aphis during the late fall, winter, and spring of 1909 and 1910 under the direction of the author. Since Mr. Hungate left the work, the author has carried it on repeating the observations in large part. The life history of the aphis has now been followed nearly a year from the stem-mothers, and experiments in the control of the pest have been made during the past season. The results of these studies and experiments are here briefly given.

Economic Importance of This Insect

In 1890, 1903, and 1908 this aphid was very numerous, widespread and destructive in the state of New York. Moreover, our records show that we received more inquiries regarding the cabbage aphis during 1909 and 1910 than about any other insect pest. It was exceedingly abundant and seriously injurious in all parts of New York State during the season of 1909 and appeared again in 1910, but did not prove nearly so injurious as last year. It not only destroys wide areas of cabbages, but many fields of cabbage were either entirely abandoned or plowed up early in the season of 1909 from a feeling of utter inability to check the pest. Some fields were plowed up in 1910 rather too early, for in most cases the parasites and predaceous enemies soon became abundant enough to hold the aphis in check.

Seasonal History of the Aphis

The oviparous females appear in the fall, are fertilized by the males, and deposit their eggs in large numbers on the leaves of the cabbage. The eggs were deposited freely during the month of October and first days of November. The first eggs were noted on October 10, 1909. No doubt some were deposited before this date. There seems to be no question but that the eggs are deposited on cabbages in great numbers and that a great majority of the eggs are fertile and hatch in the spring. Eggs were found on cabbage, rape, turnip, brussels sprouts and kohl-rabi, but in small numbers except on the cabbage. They were deposited in greatest numbers on the undersides of the cabbage leaves and were usually placed in depressions and crevices of the leaves. The egg, when first laid, is of a pale greenish yellow color, but usually soon turns dark and finally becomes almost black.

On eighteen leaves taken at random there was found to be an average of 62+ eggs on the upper sides and 115+ on the lower sides. On six leaves taken from a badly infested field there was an average of 293+ eggs to the leaf, the highest number on any one leaf being 343. Leaves bearing eggs were collected in the fall and kept outdoors under as natural conditions as possible to determine what per cent of the eggs would hatch. Under these conditions it was found that 76 per cent of them hatched when brought into the insectary in March. Whether all of the eggs thus collected were fertile or not we had no means of knowing. On the other hand, a known number of fertilized eggs were kept under natural conditions outdoors and all of these hatched the following spring. Eggs deposited on October 15 and 16 hatched in the field on March 30, thus giving five and one-half months as the period of incubation. The spring of 1910 was earlier than usual, however, and likely hatching occurred somewhat earlier than in ordinary seasons.

On April 1, 1910, the newly hatched stem-mothers were found present on the stumps of cabbage left standing in an infested field from the fall before. The field had been plowed; but many of the long stumps were left with their tops projecting and these had begun to send up new growths. In the centers of these new growths among the tender leaves, stem-mothers were found in abundance. The number was counted on five different plants and ran four, eleven, thirty-one, five and nine respectively. In another infested field not plowed, but in which the stumps had remained undisturbed, the aphids were found in varying numbers. From these stem-mothers we have reared up to the present time, December 3, 1910, twenty-one generations of agamic wingless females. The average length of each generation has been 11 4-5 days.

During the summer, generations of winged forms are produced, especially on crowded plants, and these serve to distribute the aphis to different plants.

Hibernation

In the warmer climate of the Southern States the cabbage aphis undoubtedly remains on the plants in the adult condition the season through. They have been observed all through the winter on cabbages at Agricultural College, Mississippi. In Florida, Quaintance says the mildness of the winter often allows the agamic females to carry the species through the year. It is doubtful if the adults can survive the winters of New York State.

Several plants infested with aphides were set beneath cages covered with cheese cloth and frequent observations made on the effect of the lowering temperatures. The insects throve and multiplied during

November when temperatures of 20° F. were not uncommon. By December activity had practically ceased and the aphides began to decrease in numbers. On January 4, with the temperature one degree below zero, a few were still alive but all of them succumbed during the night of the 4th, when the temperature fell to 5° below.

Reproductive Habits of the Agamic Forms

The stem-mothers molted at intervals of three or four days and matured in about fourteen days. They gave birth to young that developed into wingless agamic females. The average length of life of a stem-mother determined from the complete records of fourteen different individuals was 45.21 days. The maximum length of life was 50 days, the minimum 41 days. The average number of young produced by a stem-mother, determined from the records of the fourteen individuals, was 42.86. The maximum number was 53, the minimum 27.

From a record of many of the ordinary wingless agamic forms it was found that the average time required for maturing was 12.81 days, the average length of life 46.14 and the average number of young produced 41+. The highest number of young produced in one day was six.

The length of life of the winged forms is apparently much less than that of the wingless, at least this was true of those reared in the insectary. In no case did they live more than ten days after maturing, and some gave birth to as many as seven, eight, and thirteen young while some died without giving birth to any.

Reproductive Habits of the Sexual Females

The sexual forms were first observed October 10 and were in evidence until the latter part of November. In the case of four females whose times of pairing with the males were observed, eggs were deposited from twenty-four to twenty-six hours after fertilization. There is good evidence that some females oviposit without fertilization.

From the records of sixteen fertilized females we found the largest number of eggs deposited was five, the lowest one, with an average for the sixteen of 2.56 eggs. The intervals between the times of oviposition varied greatly. In some cases oviposition occurred at quite regular intervals while in other cases long intervals elapsed between periods of egg-laying.

Natural Enemies

The natural enemies of the cabbage aphis are numerous and in most seasons effective in holding this pest in check. The season of 1910 was especially favorable for these natural enemies and although the aphis promised in the early part of the season to become abundant, it was eventually controlled in most of the cabbage growing areas of New York State by its enemies.

The larvæ of several species of Syrphus flies have been observed to feed upon the aphides. These flies were especially abundant this year in a badly infested patch at Groton, N. Y. It was interesting to observe the flies depositing their long, oval, white eggs among the aphides. We have reared two species, *Sphærophoria cylindrica*, and *Allograpta obliqua*. In addition, *Syrphus americana* and *Syrphus ribesii* were seen to oviposit among the aphides.

The two lady-birds, *Adalia bipunctata* and *Hippodamia convergens* were exceedingly abundant this year and did tremendously effective work in destroying the aphides.

Xystus brassicæ and *Aphidius piceus* are the two most effective parasites. There were literally thousands upon thousands of aphides parasitized this season by these two insects, especially by the latter. Hundreds of Aphidius were bred from aphides brought from the field in the latter part of August. It seems to me that these two parasites and the two species of lady-birds already named, especially *Aphidius piceus* and *Hippodamia convergens*, are the most efficient natural means of control.

Other insects issuing from the boxes containing leaves of cabbage were *Asaphes rufipes* and *Pachyneuron micans*. Just how far these are true parasites or hyperparasites or both is not known to us.

Methods of Control

Clean Cultivation.—In consideration of the egg-laying habits and consequent production of stem-mothers on cabbage stumps in the spring of the year it must be admitted, it seems to me, that the disposal of all leaves and stumps is very desirable. They could be easily pulled, laid in the bottoms of the furrows and plowed under in the fall or winter. Simply plowing a field without pulling the stumps does not bury them, as was shown in a trial field during the spring of 1910.

The destruction of weeds, serving as food plants, in the vicinity of the fields should also be practiced.

Seed-Beds and Plants.—Inquiries are often received regarding the infestation of plants in the seed-beds and means of freeing the

plants before setting in the field. During the past season a series of experiments in dipping seed-bed plants in various solutions was carried out in response to these inquiries.

A home-made fish-oil soap after the following formula devised by Van Slyke and Urner was used with good results:

Caustic soda	6 lbs., or	1 1-2 lbs.
Water	1 1-2 gals., or	1 1-2 qts.
Fish-oil	22 lbs., or	5 1-2 lbs.

Simply dissolve the caustic soda in the water at ordinary temperature and when completely in solution add the fish-oil gradually, in the meantime stirring the mixture vigorously. Complete and thorough stirring while the oil is being slowly poured into the water and soda is absolutely necessary. This gives a fish-oil soap at ordinary temperatures that has no free alkali, is constant in water content, and a very effective contact insecticide.

Plants were dipped in solutions of this soap with the proportions of 1 to 8, 1 to 10, and 1 to 15. The solutions of 1 to 8 were entirely effective, killing every aphid hit. The weaker ones were not entirely effective.

No burning of the plants was induced so long as the plants were dipped singly. In a series of experiments in which many plants were dipped in bunches of dozens and half-dozens and allowed to lie until set out and in some cases allowed to lie a half-hour in the sun, burning was experienced in one case only. This was in the case of a bunch of plants that had lain one half-hour in the sun with the roots protected. The burning, however, affected only the outer leaves and the plants recuperated very quickly. In the case of those plants which were dipped in bunches some aphides always escaped being hit.

A similar series of experiments was carried out with Leggett's Anchor Brand of whale-oil soap. The solutions of 1 to 8 gave just as good results as like solutions of the fish-oil soap. The weaker solutions of 1 to 10 and 1 to 15 did not give as good results in killing the aphis as like solutions of the fish-oil soap. This, perhaps, shows a higher water content and consequent weaker solutions.

Plants were also dipped in Black Leaf tobacco extract at the rate of 1 to 100. All plants bore living aphides and no dead ones were found. No injury to leaves. When plants were dipped in Black Leaf 1 to 64 a few aphides were killed, but many were left alive. No injury to plants resulted.

These results should not be interpreted as showing that Black Leaf will not kill the cabbage louse. As a matter of fact it is a very effective killing agent for this pest when applied with force, as we have

demonstrated in laboratory and field experiments. In dipping plants, the solution simply runs off of the aphides and leaves without apparently having any caustic or killing effect whatever. If we had added a small amount of soap no doubt the extract would have stuck and done its work.

A series of plants dipped in solutions of lime-sulphur, 32.5° Beaumé, in the proportions of 1 to 40 and 1 to 30 were quite badly burned in every case and only a small per cent of aphides was killed. The tendency of the lime-sulphur to run off the leaves without apparently touching the aphides was almost as marked as in the case of the tobacco extract.

Spraying in the Field.—During the latter part of August we sprayed a very badly infested field of two acres. We used a knapsack sprayer. There were seventy-six rows (all about the same length) of cabbages in the field. We sprayed sixteen rows with Black Leaf extract 1 to 64 and used forty-eight gallons of mixture. The material was very effective; but it did not spread over the leaves readily and more material was necessary for a given area than of the fish-oil soap solution.

The remaining sixty rows were sprayed with the fish-oil soap solution at the rate of 1 to 6. The results were very encouraging. The material spread readily and killed all aphides hit. We used, on an average, 2 1-3 gallons to the row. At this rate, it would have cost to spray the two acres by hand, using fish-oil soap and counting cost of material and labor, about $2.15 per acre. In other field experiments equally good results were obtained with the proportions of 1 to 7. This would slightly lower the cost of spraying per acre.

I believe a cheaper and more effective method of spraying cabbages would be to mount a barrel with two leads of hose in a one-horse wagon and have a man on the ground at the end of each hose to direct the nozzle.

Whether cabbages can be sprayed with power sprayers effectively or not is a question upon which we need more definite information.

NOTES ON SOME INSECTS AFFECTING THE SUGAR CANE

By F. W. Urich, *Entomologist, Board of Agriculture, Trinidad*

The sugar cane has been cultivated in Trinidad for a long time and there are localities in which canes have been grown without interruption for quite a century. It, therefore, speaks very well indeed for the vigor and hardiness of canes that today there are not more cane pests to contend with than we have at present. It is true that many

changes have taken place, better varieties of canes are grown and the methods of cultivation leave nothing to be desired.

Besides the pests of old standing such as *Diatræa saccharalis*, *Sphenophorus sericeus* and *Rhynchophorus palmarum*, two insects, *Tomaspis postica* and *Castnia licus* have been more injurious than all the others put together. *Tomaspis postica* appears to have existed on cane in this island for a long time, but it was only in 1908 that these Cercopids were recognized as being the authors of a cane blight that caused considerable loss from time to time. From its original food plant, grass (several species) *T. postica* adapted itself so well to sugar cane that today a hard fight is taking place to eradicate it from sugar cane plantations. The life history of this insect has been fully worked out and some of the stages appear to be more vulnerable than others, but one of the chief difficulties in combating not only this insect, but many other insect pests in the tropics, is the continual succession of broods and continuous generation which take place. Only abnormal conditions of weather seem to exercise a slight check as far as *T. postica* is concerned, extremes of dry or wet weather keeping it down.

Contrary to the habits of some members of the Homoptera *T. postica* inserts its eggs by means of the ovipositor into the tissue of withering cane or grass sheaths instead of choosing green and growing tissues. The eggs are deposited singly, and take, in favorable weather, from twelve to twenty days to hatch. In very dry weather eggs do not hatch immediately and this would appear to be the only resting or æstivating stage of the insect. The young nymph makes its way to the ground, attaches itself to the nearest cane or grass root and surrounds itself with the spittle characteristic of the Cercopidæ. The nymphal stage lasts from thirty-two to forty-two days and during this time skins are shed four times, the cast skins remaining in the spittle mass.

When the final moult is about to take place, the nymph ascends a foot or two on a grass stalk or cane and in a kind of hollowed-out chamber in the froth undergoes the final moult. The newly issued adult remains in the chamber until quite strong and fully colored, a process requiring several hours. The proportion of males and females in the fields varies according to season, but on an average 51 per cent of the total number are males. Each female is capable of laying thirty to forty eggs. *T. postica* in its nymphal stage appears to be so well protected that no natural insect enemies have been observed, the only natural control that has been found to be of some use is a parasitical fungus, which attacks both adults and nymphs, but mostly the former. Mr. J. B. Rorer has identified this fungus as *Metarrhizium anisopliæ* Metschnikoff. Experiments with the fungus conducted on a small scale have given

such good results that it will be used on a large scale in rainy weather, the time most favorable for its growth and also the time when *T. postica* is more numerous.

Castnia licus is the other cane pest of importance, but up to now no weak stage in its life history has been discovered which would facilitate its control. The only method of dealing with it has been by gangs of boys catching adults. Some good has been done, however, for in 1909 for a period of nine months 144,606 moths were caught on one plantation and in 1910 for the same period 72,645. About 60 per cent of the total number caught are males. Each female is capable of laying from 100 to 150 eggs. Broods overlap each other and it is possible to get all stages of the moth during every month of the year. The caterpillar appears to live more in the root stocks of the canes, only tunneling up cane stalks for the purpose of feeding. The time a caterpillar takes to develop varies a great deal and depends entirely upon the nature and quantity of the food. In connection with an experiment now in progress, a caterpillar fed with sour cane has taken three months to attain what appears to be one half its full size.

Of the other cane pests, *Sphenophorus sericeus* and *Rhynchophorus palmarum* deserve some attention. These beetles are always present on sugar cane plantations and should the canes turn sour from any cause, they are certain to be attacked by one or the other or very often by both. Both are more injurious to plant canes that have not been properly treated with a fungicide before planting. The struggle for existence which goes on in a piece of cane about twelve inches long is remarkable. As a rule it will attract *S. sericeus* first, then *Xyleborus perforans* is sure to follow. These two species live together in apparent harmony and quite a number of *S. sericeus* will issue from a single cane plant. When, however, a *R. palmarum* deposits two or three eggs in a plant, things change considerably and before the palm weevil is half grown, there is only one of its larvæ to be found in each plant. Whether accidentally or intentionally, any other grub is destroyed and possibly devoured. It is a bitter struggle for existence and only one *R. palmarum* survives. The larva of each species has its characteristic way of burrowing. *Sphenophorus* works immediately under the rind of the cane and makes its tunnels outwards gradually going to the centre as the food supply is finished. *R. palmarum* bores through longitudinally up and down in any fashion and when its development is nearly completed, a cane plant is but a mass of frass enclosed in a thin shell of rind in which the larva pupates.

There are also two small borers attacking canes *Diatræa saccharalis* and *Diatræa canella*. The former seems to thrive just as well on a tall grass growing in the cane traces as on cane and the latter is generally

found on cane. Although put down as second-rate pests, a careful investigation would reveal the fact that they are not altogether to be neglected.

HABITS OF THE HONEYSUCKLE APHIS, RHOPALOSIPHUM XYLOSTEI

By MARY E. MURTFELDT, *Kirkwood, Mo.*

No species of aphis with which I have had experience—except, perhaps, the Grape Phylloxera on non-resistant varieties—has been found so persistently destructive and so almost impossible of control as the one named above. This appeared ten or twelve years ago in the gardens in and around St. Louis and on the wild vines growing in the open woods along the Merame river. It does not attack all varieties of these twining shrubs, but seems to find in the structure of the Sweet Dutch and Italian, as well as in that of the native Coral or Trumpet species, *Lonicera sempervirens*, also in cultivation everywhere—just the conditions suited to its development. The peculiarity of these species is that they bloom only on the tips of the new shoots, the blossom clusters being subtended and at first closely enfolded by a pair of bract-like leaves. Now, as the aphis colonies feed and multiply only on the flower buds and blossoms throughout the spring and early autumn, these bracts afford them shelter and concealment and their innumerable punctures cause the leafy valves to close more and more tightly over them and over the retarded buds, so that they are in a great measure protected from parasitic and predaceous insect foes and also from all dustings and sprayings with insecticides, unless these are applied with great force. Even smoking with tobacco stems under a large dry-goods box or under a canvas tent failed to suffocate them.

So far as I have been able to ascertain this aphis hibernates in the agamic, "stem-mother" form, concealed under leaf buds or protected by such scanty, withered foliage as remains on the vines. But I must confess that assiduous search has brought to notice but few of these. A very few eggs have also been found, late in autumn, generally in pairs on the tips of leaf buds. They are scarcely visible to the unaided eye, being not more than 0.2mm. in length, of oblong form, brownish black color and, so far as could be revealed under a strong lens, with a smooth surface. I have not been able to differentiate the sexes, not having made microscopic studies of the forms, but infer that true males and females are developed in small numbers late in the season as the eggs would indicate.

With the earliest setting of the blossom clusters in spring, the aphides are also found to be present and these continue to multiply and spread over the vines, so that rarely any blossom clusters perfect throughout the spring and early summer.

About the first of July the insects almost wholly disappear and the vines have a respite from their attacks and are enabled to develop a scant crop of blossoms and to make a little annual growth, but by the latter part of September the pests are again in evidence in full force and scarce a flower cluster escapes injury, if not complete destruction.

The aphides continue to multiply until the first hard frost, which wilts the protecting leaves and causes the pests to disperse over the stems and foliage and it is at this time that the winged forms seem to be most abundant.

The species of honeysuckles so devastated include the choicest varieties,—all that have smooth, somewhat glaucous foliage and bloom from their growing points continuously throughout the growing season.

The European varieties produce profuse clusters of delicately colored broad trumpet shaped blossoms, which diffuse during the early morning and evening hours a perfume of most exquisite and refined sweetness, which is withheld under the heat and brilliance of the noonday sun. Our native *sempervirens*, though scentless, was formerly one of our most vigorous and valued climbers, whose blossoms, bright red externally and soft orange within, rendered it by far the most showy of all the species.

Previous to the advent of the aphis—from whence it is difficult to conclude—all these vines were rapid growers and most desirable for shading piazzas and for trellis ornamentation. Now they only survive in the form of half-naked stems and low deformed bushes, with little of their natural habit and attraction. I have not attempted any structural description of the insect, as Professor Gillette, who very kindly made the determination for me, wrote that he would have a paper on the subject for the meeting of the Entomological Association.

I may mention further that I have never found ants attending this species and rarely, before the past summer, were lady-birds seen among the colonies, but this year the winter lady-bird *Adalia bipunctata* and its larvæ were found feeding upon a large proportion of the spring colonies and, later in the season, the latter were preyed upon to a considerable extent by the larvæ of one or more Syrphus flies from which, as yet, I have not been able to obtain the adults.

In these and possibly other natural enemies we find some ground for hope that this pestilent despoiler may be so kept in subjection, that our favorite climbers may once more display their pristine loveliness.

WHY COLLECT INSECTS?

By MARY E. MURTFELDT, *Kirkwood, Mo.*

One reason. With all the excellent and profusely illustrated Manuals of Entomology, with Doctor Holland's exquisite Butterfly and Moth Books and Doctor Howard's inclusive Insect Book and innumerable monographs, bulletins and reports on injurious and beneficial insects, it seems scarcely worth while for the amateur entomologist or the teacher, to be at the trouble and expense of making a collection of specimens. But for some reason the most accurate and attractively colored pictures fail of making an impression on the youthful mind, at least. They are so satiated with depictive art in newspapers and magazines, so much of which is caricature or exaggeration, that they have become sceptical as to the honesty of any representation which they cannot personally verify.

The teacher of agriculture in our high school this autumn, on coming to the subject of "Injurious and Beneficial Insects," applied to me for the loan of a case of specimens representative of the principal orders and especially of species of economic importance, saying that the youths were indifferent to the pictures shown in illustration of the lessons or objected to them as works of imagination—particularly the boys balked at the cut of *Thalessa lunator*, as given in Professor Smith's "Economic Entomology."

"Aw! you can't tell me that there is any such fly as that! How could it manage to get those boring threads into the heartwood of a tree?" said one.

So happening to have a good specimen of the parasite, I included it among those prepared for the school and great was the wonder and interest excited by a veritable example of the supposedly impossible species.

For several days, as I was afterwards told, that case of insects was the chief attraction in the building to both teachers and pupils and to a number of those not connected with the school, who wondered how it had been possible to collect so many lovely butterflies and moths, brilliant and grotesque beetles and other curious and attractive forms in the immediate locality in which they had lived for years—some of them all their lives—without ever having obtained a glimpse of them.

Needless to say that, after this, the lessons on entomology were not lacking in interest for either teacher or scholars and a most enthusiastic collecting fancy developed, which led to frequent consultations of the text-books for names and further knowledge of

habits, localities, etc., so that by the end of the quarter almost every member of the class had acquired a fair introduction to the science and had an intelligent appreciation of its importance as related to agriculture.

LIFE HISTORY OF THE RICE WEEVIL (CALANDRA ORYZA L.) IN ALABAMA

By W. E. Hinds and W. F. Turner

An examination of the literature relating to this species shows that our really definite information as to its life history is very scanty indeed. Only scattered and incidental references to isolated facts have been recorded in spite of its great economic importance. One reason for this is, doubtless, that the injury done by this insect is greatest in those sections of the country where economic entomology is but a comparatively new study. Another reason may be that its work has been confused with that of its close relative *C. granaria*.

In the United States, certainly, *Calandra oryza* is the far more important species of the two and here its injury seems to be of greatest importance in the Gulf and South Atlantic States especially. This is primarily on account of the milder winters and the longer season of activity during the fall when they may multiply most rapidly. The injury done by this species would seem to be one of the factors which has restricted the raising of corn and the production of livestock and tended to promote the "one-crop" system of cotton culture which has generally prevailed for a generation past. With the advance of the Mexican cotton boll weevil (*Anthonomus grandis* Boh.) the rice weevil becomes of increasing importance since the plan of fighting the boll weevil involves, as a rule, the production of more corn and the storage of the crop until it can be fed out to livestock. The rapid depreciation of stored corn has retarded the general adoption of this practice.

In this paper we can attempt to give only a general statement of the results of observations which have been accumulating in this office during the past two or three years. But we believe that much of the data will be welcomed by other workers, especially by those in the South. We cannot attempt to record any results of experiments looking to the control of the pest, but shall record the facts of life history in more detail than would appeal to the average farmer for whom a bulletin may later be issued.

The stages of the insect may be first considered:

The Egg.—The egg of the rice weevil is always deposited within the kernel of some grain. It is regularly elliptical or sometimes rather

"pear-shaped," with the larger end outward as it rests in the grain (Pl. 7, fig. 2). The covering membranes are thin and of an opaque white color. The average length of eggs is about 0.665 mm. by about 0.295 mm. thickness at the larger part. The young larva can be seen through the egg covering shortly before it is ready to hatch. Hatching occurs in an average of three days from deposition of the egg with a mean temperature of between 60° and 65° F. There appears to be a considerable mortality during the egg stage as not nearly as many larvæ develop in corn as there are eggs deposited, but the exact proportions have not been determined. It appears to be fully 50 per cent, however.

The Larva.—This stage has been figured by a few writers. Photographs are here shown of the young larva as it hatches from the egg and also of the fully grown larva (Pl. 7, figs. 3, 5). The grub is of a creamy white color except the head which is brownish shading to nearly black at the tips of the mouth-parts. It is very thick bodied, with the ventral line approximately straight while the dorsum is almost semi-circular. There are three larval stages as shown distinctly by the measurements of heads. In the first stage the head averages approximately 0.22 mm. in breadth at its widest part; in the second stage, 0.33 mm. and in the third stage 0.64 mm. The first larval stage requires about three days, the second four days and the third nine days on the average, with mean temperatures of between 60° and 65°F. There is then a distinct prepupal stage in which the forming pupa is plainly visible through the unshed larval skin lasting for usually one day. The entire larval stage, therefore, requires between sixteen and seventeen days on the average, with a common range of between fifteen and nineteen days under usual temperature conditions. The pupal cell is always formed within the kernel and may be either in the heart of the kernel or near its exterior.

The Pupa.—This instar is somewhat longer and more slender than was the grub before it (Pl. 7, fig. 6). There seems to be considerable variation in length of this stage at the same period, with the average at about six days and the range between three and nine days. Considerable brown coloration appears before the pupal skin is shed. After the insect has become adult it still remains within the kernel for several days to harden and fully mature before it makes any attempt to escape.

Naturally, with all of the immature instars, the duration of the stage is very largely determined by prevailing temperature conditions. The records that have been given relate to observations ranging from about the middle of August to the early part of November in the latitude of Auburn, Ala. The breeding of weevils continues more or less

steadily throughout the winter provided the temperature remains sufficiently high. The occurrence of a particularly cold snap, as when temperature falls to below 10° above zero, while it does not exterminate the weevils, still appears to destroy a large part of the immature stages and many adults and thus greatly retards subsequent multiplication and injury by the pest later in the winter. As a rule the greatest damage by these weevils is done before the end of December, in this State, and thereafter to corn that is stored beyond the following April.

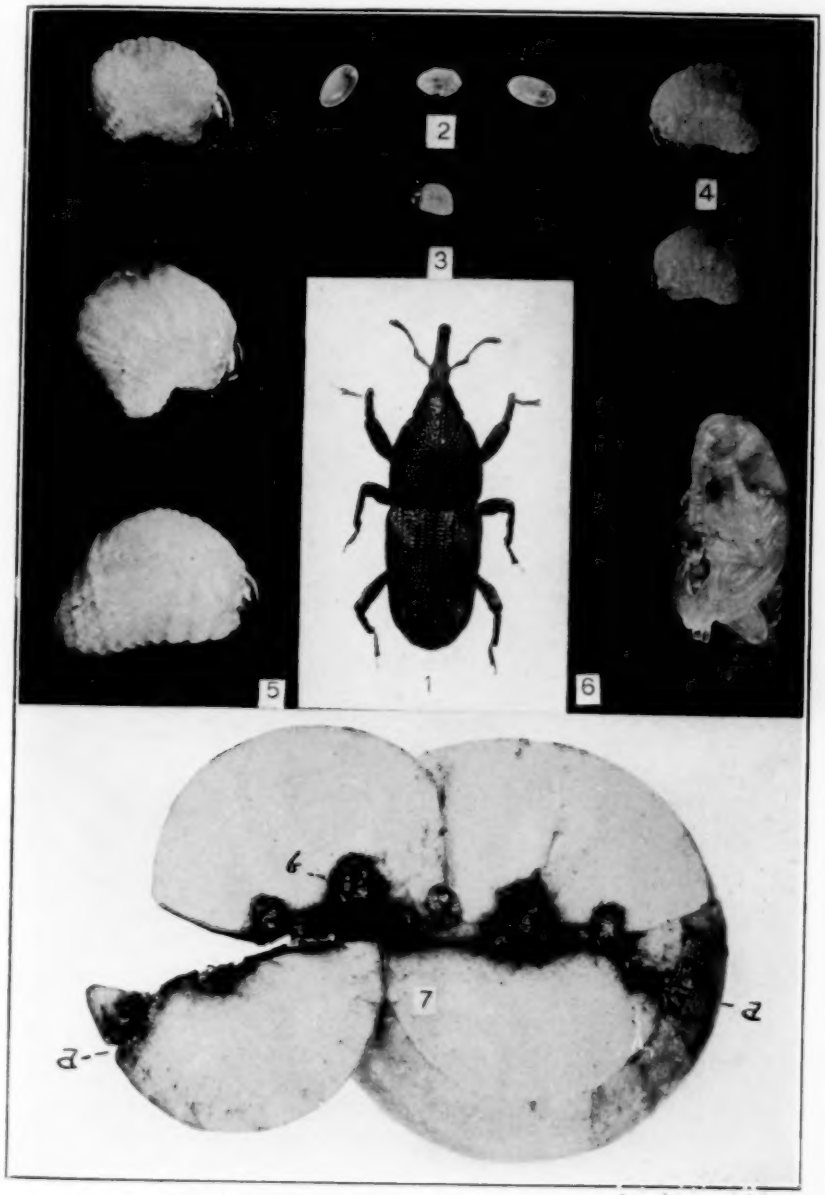
During the winter season, as from December 15 to March 15 the larval stage has been known to be extended to beyond 115 days, or about four months, in spite of the fact that the infested corn was kept in a heated building where the day temperature averaged nearly 60° with the night temperature probably 10° to 15° lower.

The Adult.—As has been said, the adult remains in the pupal cell for several days, usually three to four, for hardening and maturing before it starts to cut its way out of the kernel. Much feeding may then be done within the kernel without any attempt at emergence, so that we cannot reckon the life-cycle from observations based solely upon the time between oviposition and the emergence of the adult. Many weevils perish in their effort to escape from the kernel, being found wedged in the exit hole, usually with only the head, prothorax and forelegs free.

At an average temperature of about 63°, development from oviposition to the emergence of the adult may take place in about thirty-two days. The general average, however, is rather longer than this and for the first field generation, appears to be about six weeks and for the second field generation between seven and eight weeks. This is between about the first week of August and the last of October.

The adult rice weevil, or "black weevil," as it is often called in the South, is a rather slender, cylindrical beetle, averaging in length of body from the front margin of the prothorax to the tip of the body, about 3.5 mm. and for the length of head and snout about 1.6 mm. The normal color is a very dark brown or nearly black and is uniform except for four reddish spots located one at each corner of the wing-covers. The prothorax is densely and uniformly punctured as are the elytra (Pl. 7, fig. 1). The reddish spots and the punctation serve to distinguish this species from *C. granaria*. The average weight per weevil is approximately 0.003 gram, or more than 150,000 weevils per pound.

Distinguishing the Sexes.—This is not a difficult matter, although size and color do not appear to indicate it at all. In size, measurements of 20 females shows a body length averaging 3.5 mm. and a head and snout length averaging 1.66 mm. Among 20 males, the body length



Rice weevil stages (*Calandra oryza* Linn.) Fig. 1, adult male; fig. 2, three eggs; fig. 3, first stage larva, just hatched; fig. 4, two sizes of second stage larva; fig. 5, three sizes of third stage larva, the lower one full grown; fig. 6, pupa at middle stage; fig. 7, adult, feeding effect on apple, *a*, point of entrance, *b*, adult at work. Figs. 1 to 6 enlarged x 10; fig. 7 natural size. (Original.)

was 3.5 mm. and head and snout 1.55 mm. This shows that females average no larger in body, but have distinctly longer snouts than do males. Under the microscope or a good hand lens, there is little difficulty in separating the sexes solely upon the appearance of the snout. The male snout is plainly thicker and more deeply punctate than is that of the female.

The two sexes are produced in approximately equal numbers. On stored corn, however, many more males than females are likely to be found outside of the kernels while a larger proportion of the females are engaged in feeding on the inside of those kernels which show weevil emergence holes.

Spring Activity.—It is certain that many weevils hibernate in the fields. Large numbers were found in the course of the boll weevil investigations hibernating both in empty cotton bolls and more frequently in old corn stalks. They have been found moving in the field as early as February in Texas after a very mild winter, and as early as January 30 in Alabama Of course large numbers occur around corn cribs. It is evident, however, that in the field the rice weevil must have some other food than corn grain to survive the long season during which this is developing. What is this food normally? Of this we are not yet certain as observations are only scattering. Weevil adults are to be found in many locations before corn is ready for their attack, but their occurrence may not indicate that they are feeding there. We have no record of breeding occurring except on some grain and during the fall of the year in the open field.

Dissemination.—The possession of functional wings is another character in which this species differs from the "granary weevil" and it is very certain that it spreads in the field entirely by flight. They do not even crawl up the corn stalk to reach the ear but fly directly thereto. We do not know how far they may spread from field to field but it is certain that corn raised for the first time on ground at least a mile from where corn was grown the preceding season is certain to become infested before it is ready to harvest. Our observations indicate that the season of greatest activity in flight is coincident with the maturing season for corn. Early corn serves to concentrate most of the weevils in the neighborhood and by presenting conditions favorable for the breeding of the weevils through so much longer time, it is ordinarily much more seriously injured by the weevils than is late maturing corn.

First Attack on Corn.—Rice weevils do not seem to be able to feed on any part of the corn plant except the grain. Weevils placed on young growing corn starved to death with no evidence of feeding. Weevils placed on corn in the milk stage fed somewhat and life was prolonged

to about twice the starvation period at that season but there was no evidence of breeding on this corn. All observations show that the attack on corn does not begin until it has reached the "dough" stage. At this time the husk is drying and shrinking, so that it is also easier for the weevils to gain access to the kernels. In the South the "cotton boll worm" or "roasting ear worm," *Heliothis obsoleta* Fabr., is so abundant that very few ears indeed escape some injury from their attack and it is very noticeable that weevil injury is greater on ears which have been badly injured by those worms. They leave the door wide open for the entrance of weevils later on. The length and tightness of the corn shuck is a very important factor affecting the severity of early weevil injury.

Duration of Life Without Food.—Observations ranging from early spring to late fall show that these weevils cannot live long without food. In April the average was about nine days and in May only five days for the starvation period, while in August the average was seven days.

Duration of Life With Food.—Our breeding work has all been done with corn, although the weevil is reported as attacking other grains also. It seems that the adults cannot feed upon isolated kernels of fully matured hard corn as in all cases they died in the usual starvation period with no signs of feeding when so confined. Where feeding can take place normally, the length of life is exceedingly variable, extending in many cases, where the winter season intervenes, to six or eight months. Males live longer than do females as a rule.

It is interesting to note that the only positive observations as to these weevils feeding in the field before corn matures shows that they attack immature fruit of peach and apple, sucking the juice and gradually forming cavities within which they may be entirely concealed and even present a real burrowing habit (Pl. 7, fig. 7). On such fruits weevils have been kept alive for more than six weeks in spite of a decayed condition of the fruit.

Mating and Reproduction.—Rice weevils are both polygamous and polyandrous. Mating may occur with both sexes within twenty-four hours of their emergence from the grain. Some feeding may have occurred in the grain and also in making their exit holes. A period of about three days then ensues before females are ready to begin oviposition. Subsequent matings are common and in laboratory breeding experiments it is evident that mating frequently results in more frequent oviposition, especially after a large number of eggs has been deposited.

Oviposition.—This occurs normally on corn at a spot that may be called an "outer angle" of the kernel. Kernels at the tip are usually

first infested and later those near the butt of the ear. The female eats out a cavity large enough for the egg, occupying usually about forty-five minutes in the operation when the corn is fairly hardened, then turns, locates the cavity with the tip of the abdomen and inserts the fleshy ovipositor. The deposition of the egg requires only about three minutes and the cavity is then sealed over as the ovipositor is withdrawn. The top of the egg is just below the surface of the grain. The female will then rest for a short period before starting another cavity. Conditions are most favorable for both the adult and the young when eggs are deposited in corn which has just passed the "dough" stage. In this condition the grain can be cut with the thumb-nail and may be characterized as a "hard gum" stage. All corns, no matter how hard they may become later, must pass through this stage during which they are subject to attack if weevils have access to the kernels. Long, close-fitting shucks may serve to so retard weevil entrance that the grain may harden and become more resistant to subsequent injury.

Rate of Oviposition.—This is a point upon which we have had no previous data. It has been interesting to find out the factors affecting the rate of egg deposition. Most important of these is evidently the degree of hardness of the kernel. With corn in the "gum" stage, the maximum record obtained was twenty eggs in twenty-four hours. Daily records of fifteen or sixteen eggs were not uncommon, while the average through a period of several weeks, with a number of weevils, was about seven eggs per day. Weevils which were laying ten or twelve eggs per day on "gum corn" would be checked to two or three eggs per day on hard corn.

The period of oviposition is nearly as long as the life of the female, beginning within a few days of her emergence from the grain. Eggs may be deposited until within a few days of death. The maximum oviposition period yet found is 110 days, but this female is still active at this writing. During this period 417 eggs have been deposited. Still another weevil deposited 374 eggs in the laboratory in addition to what she may have deposited in the fields before she was captured. The maximum record, however, includes the entire deposit as the weevil was bred.

Life Cycle and Generations.—The average duration of the life cycle during August and September is between seven and eight weeks. Generations, therefore, become wholly mixed within a short time. It appears, though, that about three generations are developed on early maturing corn before the middle of December and two generations with medium late corn. Infested corn, which has been kept in receptacles in the laboratory has shown but two generations for the

entire season and it is evident from the length of life occasionally found that a single generation might span the entire season.

Mortality.—This appears to be greatest during the coldest part of the winter season, when large numbers of the adults, as well as many of the immature stages, die. Accordingly, in March, after an average winter in this locality, but 14 per cent of either immature stages or adults were found alive.

In the field, during the fall, largest mortality appears to be with eggs and young larvæ. There is also considerable mortality during the prepupal stage and with adults in the act of emergence.

Parasites are not uncommon and two or three species have been bred from immature stages of the weevil.

Parthenogenesis:—It is interesting to note that we have found strong evidence of the common occurrence of parthenogenesis among rice weevils. Unfertilized females deposit eggs occasionally but much more rarely than is normal. Many observations have shown that these eggs may hatch. We have bred a male and a female weevil from eggs deposited by a positively unfertilized female. Their development required about five months, from October to March, in a heated room.

INJURIOUS INSECTS OF 1910 AT TREESBANK, MANITOBA

By Norman Criddle

The areas covered by this paper contains most of the types of soil found within the Province of Manitoba and a fair percentage of the kind of crops grown. It also embraces open country and woodlands of different sorts, so that, on the whole, we might expect to find within its borders most of the insect pests that inhabit other portions.

Owing to an exceptionally dry season cereal crops were, generally speaking, very poor and this made the inroads of some insects, notably grasshoppers, much more difficult to control than they would otherwise have been; it also caused several pests of importance to be overlooked, the poor condition of grain being generally put down to unfavorable weather conditions.

Insects Injurious to Grain and Grasses

Hessian Fly, *Mayetiola destructor.* — Injury was reported to be rather extensive in some localities but investigation did not bear out the reports, but revealed that most of it was due to other insects.

The Greater Wheat-Stem Maggot, *Meromyza americana.*—This and probably the Lesser Wheat-Stem Maggot (*Oscinis carbonaria*)

are responsible for most of the injury to young wheat that is noticeable almost every spring and put down to other causes, such as Hessian fly, wire worms, rot, etc. The attack is recognizable by a patchy appearance of the growing grain; odd plants, or more often several in succession may be seen to have wilted away. Examination will show that plants look as if they had been pinched about an inch below the ground, or to have rotted at that point; while a careful search usually reveals one or more whitish or greenish maggots which are very small at that time. About a month later, as wheat shows signs of heading out, there is another generation which causes the well known "White heads."

During the present year injury to young wheat was not as extensive as in 1909, though probably at least 1 per cent of young plants were killed. In July adults of *M. americana* could be swept up in fair numbers from grain fields and many stems of wheat were infested with larvæ. I note that this insect seems to be very partial to couch grass—*Agropyron repens* and *A. occidentale*. On a patch of the latter flies were collected weekly from May 6 until September 21.

Western Wheat-Stem Sawfly, *Cephus occidentalis*.—This is an insect that usually confines itself to native grasses upon which it subsisted entirely before the introduction of grain; its food plants being species of the genus *Agropyron*—especially *A. caninum*. Happily *A. tenerum*, which is now so extensively grown in western Canada, has proved almost immune, due, no doubt, to its more slender stems. This sawfly, however, readily adapts itself to new conditions and having once become established, seems to have a preference for the plants that it fed upon in its early stages. In 1906 owing to a failure of its native food plant to produce heads, it swarmed to the wheat fields, where it soon became established and, in some cases, where proper precautions were not taken, remained ever since. As there are still some details lacking in the published accounts of its habits, it may not be out of place to give a more detailed account of its life history.

The flies appear on an average about June 15, when they can be observed, resting head downwards, upon stems of grain and grasses. They deposit their eggs towards the end of the month at the time wheat is showing indications of—or is—heading out. The operation has not been observed, but doubtless the eggs are laid singly in the stem near the head by aid of the short ovipositor. The egg hatches within a few days and the larva commences to work its way downwards by eating out the inner tissues, and reaches the ground about the first of August. It then gnaws a ring around inside, causing the stem to fall down, then makes a chamber of the stub by covering the surface

and lining it inside with a silky water-tight substance exuded from the mouth. In this retreat it passes the winter—turns to a pupa late the following May and appears as a perfect fly in June.

The chief injury is due to the breaking down of wheat stems during winds and to their being cut through when the insect enters the ground.

The principle remedy lies in banishing the insect from cultivated ground as it will then only appear when its native food plants fail to produce heads.

Experiments with a view to discovering what depth of covering the fly could make its way through, proved that four inches of earth, when packed, was sufficient to prevent this, but that six inches were required when the earth remained loose. In working their way out at this depth, the flies are unable to keep a perpendicular direction and gradually turn over backwards making, if they live long enough, a complete circle. They seldom survived, however, a sufficient time to accomplish this, dying within fifteen hours.

Taking into consideration its life history the following remedies were tried and proved effective:

(1) Plough all infested stubble land before June 15, not less than four inches deep, to be afterwards packed, or six inches deep without packing.

(2) Cut all infested grass, between July 10 and August 1. This will catch the larvæ in the stems before they reach the ground. Burning infested stubbles or grasses in order to destroy larvæ while hibernating is absolutely valueless as all larvæ remain well out of reach below the ground.

The injury to growing grain during 1910 was not as extensive as it was the previous year, though in some places on odd fields it probably exceeded 2 per cent.

Wire Worms, *Corymbites æripennis* Kby.—Slightly injurious to grain crops in spring and later to potatoes.

Grasshoppers or Locusts.—These insects became very abundant during the season and did some injury to cereal crops in spite of the repressive measures adopted. Fortunately a backward spring delayed their appearance, so that all vegetation became well advanced before they commenced to attack it. The chief damage was done after locusts commenced to fly, as it then became a costly and difficult matter to spread poison bait over such an extended area, especially as the remuneration—due to bad crops—was not great. The "Criddle Mixture" again proved far superior to anything else, after locusts had once hatched, and in the Aweme district where it had to be applied frequently, it caused great destruction among the insects and unquestionably saved

many crops. The successful application of this mixture is largely due to weather conditions. Firstly, the day chosen for spreading it should be sunny with the temperature above 60° F. in the shade. Secondly, dry conditions will always prove advantageous and bring greater results than wet, as then the mixture will be attractive on account of the moisture it contains, apart from any other attraction. Indeed, on hot, dry days locusts will often travel some distance towards a receptacle containing water. Thirdly, it is advantageous to spread poison during the warmest part of the day, as it is then that grasshoppers are most easily enticed towards it.

An examination reveals many egg masses present on stubble and other suitable land, so that under ordinary conditions another outbreak of greater severity may be expected in 1911.

Several parasites were present. Firstly, a Tachina fly caused many deaths during July and then three species of blister beetles were present in unusual numbers, namely *Contharis nuttalli*, *Epicauta pennsylvanica* and *E. sericea*. The first two subsist largely upon members of the pea family though the second did some injury to potatoes and beans. The last appears to confine itself to lamb's quarters.

An extensive migration commenced among locusts late in July and continued, when the weather permitted, until the 16th of August. The days chosen were hot and sunny with a moderate breeze. Looking up towards the sun with sufficient shelter to hide its disc, revealed a continual swarm passing by with the wind from a few feet above the ground to as high as sight could detect the glistening wings when passing near the sun.

Injury was also caused by eating through twine used to bind sheaves, in some places fully 70 per cent being cut through. Soaking balls of twine in two pounds of copper sulphate to ten gallons of water proved a perfect preventive, though it has a tendency to rot the twine and cause trouble when binding. If dried very quickly, however, this is partly avoided.

Locusts responsible for most of the injury done were, *Melanoplus atlanis*, *packardii*, *angustipennis*, *bivittatus*, *extremus* and *dawsoni*, in the order named.

Insects Injurious to Roots and Vegetables

Imported Cabbage Worm, *Pontia rapæ*.—Much less injurious than last year and did comparatively little injury.

Colorado Potato Beetle, *Leptinotarsa decimlineata*.—We experienced the worst outbreak on record of this insect. No potato patch was free from it anywhere.

The Manitoba beetles are considerably later in making their appearance than farther east and south. Here the first are generally noticed about June 15, at the time when potatoes are just making their way through the ground. In 1910 the first larvæ were observed June 13, and these reached the adult state July 16, and became sexually mature towards the end of the month. On August 8 some of these commenced depositing eggs and larvæ were noted a few days later. A few of these pupated the second week in September, but no beetles appeared from them, and their condition late in October left little doubt that most, if not all, of them would perish during the winter.

Successive applications of Paris green proved perfectly satisfactory.

There was also a remarkable outbreak of June beetles, in the larval state. One species—*Lachnosterna fusca*—was so plentiful that it caused the total destruction of large patches of native grasses, in some instances covering an area of half an acre or more. These were well up on the grass land, while another species did some injury to potatoes in moist situations.

Trees and shrubs also suffered from the ravages of several insects during the year, of which the following were the most important:

The Willow-leaf Beetle, *Galerucella decora.*—Overwintering beetles appeared in swarms as soon as willows commenced to form leaves and in the course of a month had almost defoliated most of these shrubs, after which they vanished, being very severely attacked by a red mite and doubtless by other parasites.

This beetle appears every few years and occasionally is the cause of much injury to aspen poplars (*P. tremuloides*), apart from completely skeletonizing several species of willow. The chief damage to aspens is when they commence to leaf out before the willows or later in the season when the latter, through defoliation, are no longer available for food. The larvæ seem to be entirely confined to species of Salix. There is but one brood in a season.

The Aspen-poplar-leaf Beetle, *Lina tremulæ.*—This is another pest that kills many young trees every eight or ten years, besides making aspen bluffs almost uninhabitable at certain seasons, owing to the very disagreeable odor of the larvæ. The species is gradually increasing and may be expected to become very injurious again within the next two years.

Pepper-grass Beetle, *Galeruca externa.*— Were in very large numbers in places where their favorite food plant (*Lepidium*) was prevalent, and in consequence did much good. Years when this plant fails however, they are apt to attack other cruciferous plants and have been known to extensively injure young turnip and cabbage plants.

Several pests of lesser importance occurred during the year. Currants suffered rather extensively from currant Sawflies. Cattle were much annoyed by Horn flies which were more numerous than ever before in Manitoba, in spite of a very dry season. Stable flies also appeared in greater numbers than usual, while several species of *Tabanus* were unusually prevalent in July. House flies seemed to invade the whole country, not even the prairie far removed from dwellings being free from them.

THE COTTON SQUARE-WEEVIL OF PERU AND ITS BEARING ON THE BOLL-WEEVIL PROBLEM IN NORTH AMERICA

By CHARLES H. T. TOWNSEND, *Piura, Peru*

The year 1864 witnessed the first modern planting of cotton in northern Peru. Several years of civil war in the United States had so shortened the world's cotton supply that promise of great profit was held out to the Peruvian planter. This, therefore, was the reason for the beginning of cotton cultivation on a large scale in the Department of Piura, which now produces and has produced for many years one of the very finest qualities of cotton fiber in the world.

The first year's cultivation seems to have developed no noticeable plague. The following year a considerable area near the Andean foothills was planted to cotton. This region is cooler and moister during the summer than are the Piura and Chira river valleys, where the planting of the previous year had been done. In this foothill region there was observed at that time a condition which has ever since been known in Peru as the "hielo" of cotton. Its chief symptom is the falling of the squares before the flower opens. It was considered to be due to cold, whence the name, the word "hielo" literally meaning ice.

While the temperature in this region, from coast to foothills, never falls below 50° or 60° F., yet in the lower valleys the nights in July and August become very cold by comparison with the summer heat of January to March. The humidity is also greater in the former months, in fact, from May or June to October or November.

The falling of the squares was so serious in the above-mentioned foothill area as to cause the abandonment of cotton culture there later on. During the forty-five years that have elapsed since then, the so-called hielo has caused more or less serious damage to the cotton crop throughout the Department of Piura, as well as in other parts

of Peru, but practically only through the winter months from July to September, or June to October, the period of greatest cold and humidity. All causes have thus conspired to lay the blame for this damage to low temperatures at night followed by hot sun the next day, causing the squares to yellow, wither and drop to the ground or remain dried upon the plants. It is estimated in Peru that the effects of hielo have resulted in more damage to the cotton crop than all other causes combined.

During the past year the writer discovered the presence in the squares of cotton in the Piura and Chira districts of a limited number of weevils appearing like a minature boll-weevil. It was at once recognized as a species of Anthonomus distinct from the boll-weevil, but exceedingly like it to all appearances except in size. Specimens were sent to Dr. L. O. Howard, chief of the Bureau of Entomology in Washington, who replied that Mr. E. A. Schwarz pronounced them an undescribed species of Anthonomus, quite different from *A. grandis*.

A later letter from Doctor Howard statest hat Mr. Schwarz had gone over all the literature and finds that there has been only one species of Anthonomus described from the present region or its vicinity—this species is *A. vestitus* Boheman, described from the Island of Puna, in the Bay of Guayaquil, Ecuador; and, while the description agrees fairly well with the specimens of the square-weevil sent, nothing certain can be said about their real identity. The letter adds: "The trouble is that your Anthonomus, while radically different from our cotton boll-weevil, belongs to the least marked and least interesting group of the genus, where positive identification can only be obtained by comparison with the type. Moreover, it is well known that the localities in the work where Boheman described his *A. vestitus* got considerably mixed up."

This weevil is, to all causal intents and purposes, an exact minature of the boll-weevil, being about one third to one fourth the size of the latter. It works in exactly the same manner on the squares, feeding in them and depositing its eggs therein. Its small size, however, allows a remarkable number of weevils to develop in one square. I have taken as many as six adult weevils from one small square, all of which had developed to maturity therein. Numerous weevils were reared from both dried and green squares, both hanging and fallen squares; numerous grubs were found in the same, and reared to maturity. The weevil was found to occur commonly and generally, but in limited numbers, throughout the cotton districts of Piura Department during September and October; and further investigation develops its presence as almost certain throughout the cotton regions of western Peru and Ecuador. It is not known certainly to be present

in the moñtana on the east slope of the Andes, but facts point to the probability of its presence there. After careful study of the matter and comparison of the conditions in each case, it seems evident that the symptoms of the hielo and the effects and habits of the weevil are quite coincident throughout; and therefore that this damage which has been generally mistaken during the last forty-five years in Peru for the effects of cold and humidity, followed by heat, is in reality due to a close relative of the boll-weevil, working in the same manner as the latter.

A few persons had maintained the belief that the hielo was due to some insect or other animal organism, but no one had succeeded in finding the culprit. During the year 1910, in September of which I first discovered the weevil, the damage has been much lighter than usual, few of the weevils probably being present as compared with former years.

It was ascertained that about twenty-three days elapse from egg to adult during September and October. This time is doubtless shortened in November and December, until the hot weather of January puts an effectual stop to further breeding and causes the weevil to seek æstivating quarters. During the colder weather of July and August the life-cycle period is probably fully four weeks.

The adult weevils vary in length from 2.25 to 3.5 mm., and in width from .75 to 1.5 mm. On first issuing they are distinctly yellowish in color, but become grayish or darker with age. There is a patch of darker shade at the junction of the bases of elytra, due to fainter pubescence, and a less distinct one on each of the elytra posteriorly, producing the effect of a faint pattern.

Search during September and October, for weevils feeding and ovipositing in the squares, gave an average everywhere in the cotton region of Piura Department of one weevil to about twenty or twenty-five squares. Yellowed and dried hanging squares and fallen squares collected in the field gave a high percentage of infestation, which has not yet been computed but will doubtless average eighty per cent or more.

Two species of parasites have been reared in considerable numbers from the weevil grubs in the infested squares. They are probably *Bracon* sp. and *Urosigalphus* sp. Both are about equally abundant, though perhaps the latter is somewhat the more numerous. The percentage of parasitism has not yet been determined, but the indications so far are in the neighborhood of thirty per cent and perhaps very much more.

The heat from January to March in the northern coast strip of Peru is excessive, and the rainfall is practically *nil* for long periods

of years. The last thoroughly wet summer here was in 1891. During the cooler months, from June to October, there is considerable moisture in the air, especially during the night and the early forenoon. The weevil can flourish here only during the cooler weather, its greatest influence on the crop being visible in July and August. Cold, with humidity, is thus seen to be the indirect cause of the damage, in so far as it allows the weevil to become and remain active.

It was noted in Piura Department that the season following the wet summer of 1891 showed a practical absence of hielo symptoms, the heavy floods having probably destroyed the major part of the weevils in the cotton districts.

It should be noted here that I have not as yet found the weevil attacking the bolls to any extent whatever. So far as I have been able to ascertain, its injury is confined to the squares, and the term square-weevil therefore seems fitting. But it must be stated that cotton grows and produces squares the year round in this country, and it is highly probable that in the absence of squares this weevil would attack the bolls in much the same manner as the boll-weevil.

Since the present species is so closely similar to the boll-weevil in general form and appearance, if not in structure, and has practically identical habits, it may be seen that its investigation throws important light on the boll-weevil problem in North America. While the boll-weevil has spread northward through Mexico into Texas, and eastward into the humid cotton area of the Southern States, it has been noted with surprise that it has never become established in the extensive cotton growing region of Mexico known as the Laguna District. The latter is extremely hot and dry, lying as it does in a low basin of the plateau region. On a trip which the writer made to Yucatan in May, 1896, only one specimen of the boll-weevil could be found. May is the height of the dry season in Yucatan, and the weather was extremely hot. The boll-weevil is much less serious in the central and western parts of Texas than in eastern Texas and Louisiana. The former are very dry and hot as compared with the latter. It has been noted that since the boll-weevil entered the humid part of the cotton belt its progress has been much more rapid and its damage more serious. It has long been recognized that heat and drought are the most potent factors in the natural control of the boll-weevil, but we were not at first prepared to accept them as an actual barrier against its spread. Such, however, seems to be very largely the case. Comparing the facts in both cases, it becomes evident that the boll-weevil of North America and the square-weevil of South America are alike in their inability to withstand great heat and drought.

It may be inferred as extremely probably that Anthonomus is a

humid boreal type which has been gradually spreading southward during recent geologic time, probably since the last advance of glacial cold. It is not yet adapted generally to the conditions of the warm arid regions, but has extended southward especially within the confines of the humid plateau area. The boll-weevil has been found as far south as the high interior of Guatemala; while its smaller relative, the square-weevil, occurs in the warmer mountain region of South America. These facts account for the rapid spread in recent years of the boll-weevil northward and eastward into the cotton belt of the Southern States, and its ready adaptation to conditions of winter cold. Its greater multiplication in the humid areas of eastern Texas and Louisiana is in accord with these facts.

Quite possibly both weevils have no other present food and main plant than cotton, having become adapted to it perhaps within the lifetimes of the species. The immediate stock from which they sprang doubtless possessed some other malvaceous host-plant. One might imagine that the boll-weevil, from its larger size, has been longer adapted to cotton than the square-weevil. In spite of much search, including a three weeks' overland trip into the Andes of southern Ecuador, from which I have just returned, I have as yet found the square-weevil on no other plant than cotton. Still more strange to say, on the above trip I was unable to find a single weevil in squares of cotton plants in the higher country after leaving the Chira valley, although conditions for them seemed most favorable. My route was northeast, toward the center of the Cordillera; and I am constrained to believe that directly north of here, in southwestern Ecuador, the weevil may be found, but probably only in wild cotton.

In view of all the facts in the case of both weevils, it is evident that great interest attaches to the question of the native home of the cotton plant. I have long been inclined to believe that it is not native to America, but came originally from the Orient, the seed having been brought here thousands of years ago by those early adventurers who gave rise to the Maya and pre-Inca civilizations of Central American and Peru. With the hope of throwing some light on this very obscure point, I have communicated with several prominent archæologists and botanists who have made special study of the subjects and regions in question. Dr. Max Uhle, director of the Museo de Historia Nacional, in Lima, and the leading authority on Peruvian antiquities, writes me as follows:

> The culture of the cotton plant in South America must have been known at a very early period. It must be so since the cultivation of *Algodon silvestre* is found everywhere east of the Cordillera. The grave finds of cotton textiles, cotton seeds and seed-pods date from the remotest times. Also with the primitive fishermen of

Ancon and Supe, cotton fabrics were known and used at a period long before the Christian era. The native cotton plants of central and southern Peru of prehistoric times were quite different from those introduced from North America and elsewhere. That variety which is cultivated at Piura is closely related to the native plant of pre-Spanish Peru (central) and also to the *Algodon silvestre* of the region east of the Andes, both in size and in general type, and doubtless is a derivation of the primitive native plant. I do not know wherefrom (in Africa or Europe) it could have been introduced originally. I, as an archæologist, am satisfied to regard it as a native plant. It is, however, remarkable that there is a cotton plant of similarly high stature and like perennial character in India. This is a question I leave to the botanists to clear up.

Mr. G. H. Powell, acting chief of the Bureau of Plant Industry, in Washington, in the absence of Doctor Galloway, chief of the Bureau writes as follows:

I beg leave to state that the nearest wild relatives of the cotton plant are all natives of America, and the tree cottons of the American tropics have doubtless always been American. In the northern part of the Andes the natives knew how to spin cotton even before they were acquainted with the llama and vicuña, as is shown by the numerous clay spinning tops found in Colombia. Almost all of the primitive languages of Central and South America have distinct words for cotton. The origin of our present upland cotton is somewhat in doubt, however, and recently evidence has been presented with the object of proving that the upland type of cotton was first developed in Asia.

The Asiatic series of cottons have no representatives in the New World, except such as are known to have been introduced; and, on the other hand, Asia possesses no species of *Ingenhouzia* and *Cienfuegosia*, the nearest wild relatives of the cottons.

Prof. T. A. Cockerell, of the University of Colorado, writes:

The genus *Gossypium* has native species in the neotropical, Ethiopian, Australian and Oriental regions—even (*G. drymarioides*) in Hawaiian Islands. It is evidently an ancient genus. The Australian species are perhaps to be separated as *Sturtia* R. Br. 1849.

The consensus of opinion thus seems in favor of the nativity of cotton in America, and I will not attempt to deny its probability. It has certainly quite evidently existed here for a very long period of time.

It is thus possible that the square-weevil has, in any event, existed in Peru as a pest of cotton for upwards of 2,000 years. The Incas cultivated cotton here, probably more in the cooler and damper areas of the country than in the present area. It is significant that the weevil took hold of the crop the second year of its more recent planting in Piura (1865). It must have been present in the country, perhaps in wild cotton. Similarly it is probable that the boll-weevil has existed in cotton in Central America for a much longer period than 2,000

years. The old ruins of Yucatan, southern Mexico and Central America were built by a race which long preceded the Aztecs. They almost certainly cultivated cotton, and it is highly probable that they brought seed with them when they came to America. They quite certainly came from the Orient, probably from India, perhaps from Egypt. The possibility is thus introduced of the boll-weevil and square-weevil as well having both been imported into America from the Old World by these ancients thousands of years ago. No statements are intended to be made by the writer in this connection, but the points of possibility are merely mentioned. The testimony of students of *Anthonomus* is needed in this connection.

Considering all the foregoing facts as well as possibilities, and especially the influence upon the weevils of high aridity in the warmer regions, what, then, is the outlook for future cotton production in the Southern States and in Peru? We know not only that the boll-weevil is by far the most serious enemy of cotton that exists under present conditions in the Southern States, but also that it is bound to invade the entire cotton belt in spite of all measures that can be taken to prevent it. Its great seriousness rests on the fact that practically all of the cotton belt of the Southern States lies within the humid, warm temperate region. The square-weevil of Peru, though a potent factor at times under present conditions, here holds no such serious menace to the crop; and this is because the cotton area of Peru lies practically all within the arid coast strip.

It should be recognized by cotton planters that the warm arid regions of the globe, with their long, hot and dry summers, served with a certain amount of irrigation, have been found to produce a far higher quality of cotton fiber than has ever been raised in humid regions. The native Peruvian, and other varieties of cotton cultivated in the excessively dry and hot coastal valleys of Peru bring as high as twenty-four cents gold on the Liverpool market, and average twenty cents or more. While the upland cotton of the Southern States is bringing fourteen cents, exactly the same variety produced in Piura Department brings twenty-two cents. The difference is entirely in quality of fiber, due wholly to the climatic conditions of the hot arid region with its great heat and dryness.

The natural cotton regions of the world are Egypt and the Soudan; the southwestern United States; northwestern Mexico; the west coast of Mexico, Central America, and South America in certain districts, as notably the coast strip of Peru; parts of South Africa, India, etc.

The natural cotton region of North America may be defined as follows: Western Sinaloa and Sonora, southwestern Arizona, south-

eastern California, the Laguna District of Mexico, with certain hot semi-arid districts of the Pacific coast of Mexico and Central America. A small part of southwestern Texas might also be included. The time will no doubt come when cotton production will be abandoned in the humid area of the Southern States, and the area of production of this crop transferred to the warm arid region just mentioned. When the boll-weevil has become distributed throughout the present cotton area of the United States, the annual loss from its effects, in spite of all methods and agencies that can be brought to bear against it, will probably exceed $50,000,000. Why should this loss continue to be incurred and carried year after year, when a new cotton region which will produce a far higher grade of fiber worth a higher price awaits exploitation?

Let the Southern States raise other crops that are better suited to their conditions, and move the area of cotton production to the southwest where it belongs. The boll-weevil will not trouble it there. Such action will not be realized for several decades, it is safe to say, and I will no doubt be set down as a foolish theorist for making the suggestion. However this may be, I rely upon my firm conviction that the change will come eventually and that time will prove the soundness of the suggestion. This change will be, moreover, brought about primarily by the influence of the boll-weevil. Thus the plague will prove a blessing in disguise.

The arid cotton districts of Peru have little to fear from either of these weevils. The native Peruvian and other varieties of cotton here are allowed to grow and produce for several years in succession, the first variety giving its best crop during the second year. Such system of cultivation allows the weevil full sway, so long as it can withstand weather conditions, and also favors greatly several other serious pests as well. A change in system of cultivation to that of North America, or even the cutting back of the plants once a year, will effectually put the crop beyond the reach of the weevil here, and at the same time reduce other pests to a minimum including the piojo blanco. Thus North America needs for the betterment of its cotton production the hot arid climatic conditions of Peru, while the latter needs for the same purpose the North American system of cultivation. Supply these respective needs by a simple exchange of ideas put into active execution, and the cotton crops of both countries will be practically free of plagues.

A SIMPLE AND CONVENIENT SYSTEM OF KEEPING GENERAL ENTOMOLOGICAL RECORDS

By CHARLES H. T. TOWNSEND, *Piura, Peru*

The system described below was devised a year ago by the writer on his arrival in Peru. It is especially adapted for use in a region where little or no entomological work has previously been done, and where much time must elapse before determinations of species can be secured, but it is equally applicable to all general entomological work. It has been in use for a year, and has so far fulfilled every reasonable expectation.

Note slips of the standard card-catalog size are used, but any size desired can be substituted for these. Colored cards are used for heads. Plant names are the chief heads, but certain others are included as suit the needs of the work. A single species of plant may form a head, or a single genus; and likewise a single species of insect, or a group of insects. Insect heads are used only for certain groups or categories that do not fall naturally under plant heads, or for certain injurious species that are being exhaustively investigated and dealt with economically.

The heads are allotted numbers from 1 to 1,000, usually two numbers being reserved for each. In exceptional cases four numbers are reserved for a head. Thus *Hemichionaspis minor*, which as a pest of cotton, is being specially investigated in Peru, is allotted numbers 1, 2, 3, 4, head to include not only that species but all allied species whose parasites promise well for use against it. Two numbers are given to *Dysdercus*. Six numbers are reserved for the cotton square-weevil and its allies, whose parasites may be used against it; since it has recently developed that this newly discovered cotton weevil is the cause of more damage to cotton in Peru than all other insects combined. Two more numbers are given to all other cotton insects. The great mass of heads are plant heads, but non-plant heads other than the above are human and animal disease-transmitters and parasites, wasps, bees, stored foods, silk, hides, drugs, collected microparasites and others not connected with hosts, coccinellids, ants, termites, locusts, household insects, jiggers, ticks, museum pests, etc. These are all the non-plant heads that have so far been needed, and these with the plant heads have brought the numbers in a year to the 800-mark.

When the first thousand numbers have been used for heads, the same numbers can be used over again with the letters of the alphabet prefixed; as A1 to A1,000, B1 to B1,000, etc. This allows of an indefinite number of heads. The heads and slips are arranged consecu-

tively by numbers. The colored catch cards bear the head, and its initial numbers, as:—247,—248, citrus fruits.

Under each head numbers are multiplied as follows: A head with numbers 247, 248, follows these numbers with 1,247, 1,248, 2,247, 2,248, 3,247, 3,248, etc. Thus a head with two numbers admits of two hundred species being placed under it before the numbers reach the six-figure space. In all cases the final numbers are the same for a head.

The system, as so far outlined, applies only to insects that are found on their respective food-plants, and to those falling under the non-plant heads adopted.

All enemies, whether parasites or predatory insects, of the species under the above heads, are designated by adding to the host-number the following:

°a — Egg-parasites.
°2a — Dipterous entoparasites of any stage.
°3a — Hymenopterous entoparasites of any stage.
°4a — Heteropterous predators of any stage.
°5a — Coleopterous predators of ditto.
°6a — Lepidopterous predators.
°7a — Dipterous predators.
°8a — Neuropterous predators.
°9a — Hymenopterous predators.
°10a — Acarid ectoparasites or predators.

Other enemy heads can be added for stylopid or other entoparasites, and for other predators or ectoparasites, etc. The letters of the English alphabet are to be used, and then doubled, tripled, etc., if required; as 247°3a to 247°3z, 247°3a2 to 247°3z2, 247°3a3 to 247°3z3, etc., variations as preferred may be adopted.

Hyperparasites, etc., can be numbered with a repetition of the above enemy suffixes added to the host-number; as 247°2a° 3a to 247°2a °3z, etc.

I have used the suffix °20 (a to z, etc.) for fungous diseases; others can be added for bacterial diseases, etc.

It will be seen that this system is highly elastic, and can be used at once before the names of any of the species of insects are known. Only the names of the plants are needed.

An index of the heads is kept separate, for the purpose of readily finding the numbers belonging to each.

With any other system the greatest confusion exists until the species of insects are known by name. With this system, order is maintained throughout, as well as a food plant catalog of the species.

Under the present system, as soon as species are identified, the slips belonging to them may be arranged under generic heads in alphabetic order, thus transferring the same slips from the original plant and other head system of the first index to a second index system using the generic names of the insects. At the same time the names of the insects are entered under the original plant and other heads, and the first index is thus retained as a cross-reference catalog to the food-plants and habits.

It will be seen that when a species has two or more host plants or host insects it will receive as many numbers under the respective heads. Also species associated with one being specially investigated for purpose of bringing together at a glance the parasites available for the latter will take further numbers in consequence. This may be thought a serious objection, and on this account I at first had some misgiving as to the system, but it has not proved so in practise. It makes no difference finally how many numbers a species may have, since each number must necessarily refer at once to the species; on the other hand, it would cause great confusion if two or more species were to appear under the same number. Upon the identification of a species, all the slips, under whatever numbers, come together under its name in the second index, and at the same time the records are left for cross-reference in the first index. The first is a number index, relating to food-plants and habits; the second is a name index, relating to genera and species. The first index system, with names incorporated, will be found of immense practical advantage as a supplement to the second index system.

While this scheme has been devised to meet the wants of an isolated region where entomological work is being inaugurated practically for the first time, it will be quite readily applicable to general economic work at any stage of records. Such species of insects as have been determined will appear in the second index while all notes on species still unnamed may be renumbered and arranged, with new slips of those determined under the first system which is thus elaborated into a food-plant and food-habit index. Such renumbering should prefix some character to the above numbers, as N (meaning new number), or an asterisk or Greek letter, or the number may be written in red ink or otherwise distinguished until the old numbers have been exceeded. The new numbers can be added to the specimens without removing the former numbers. For the second system a generic index is found in the head cards alphabetically arranged. The beauty of the whole scheme is that it is capable of immediate application, without the necessity for the names of the insects being predetermined, and of systematic and unlimited extension on the same lines as begun, the

records of any species being at once available at all times. I am able at a moment's notice to find any particular note that I have made during the past year on any one of the hundreds of species of insects studied, whether yet determined or still without name, and anyone who familiarizes himself with the scheme as outlined can do the same. This is of course the test of any system of note keeping. Its proof is in its convenience and utility. I know of no other general record scheme that is at once so simple and so conveniently available at all stages of the work.

SOME WAYS OF REACHING THE PUBLIC

By H. A. Gossard

Last year I presented by title to the Association of Economic Entomologists a paper which has since been published in the Journal of Economic Entomology on "The Value and Make-up of State and County Fair Exhibits." In this, I discussed *one* of the methods I use to acquaint the public with the entomological work of the Ohio Agricultural Experiment Station. This special feature of our work will, therefore, need no further mention in this paper. It is with the hope that a discussion of other methods of gaining publicity may bring to me some profitable suggestions from my fellow-workers and that I may impart a few to them that I offer this paper.

Of course, the main reliance of the official economic entomologist for publishing his results must be through the customary medium of publicity used by the institution with which he is connected. This is usually by means of the bulletin, circular and annual report. Professor Sanderson has given so good a discussion relating to "Publications of the Station Entomologist" in No. 4, Vol. 2 of the Journal of Economic Entomology that I shall pass over this subject quite briefly.

I wish, however, to emphasize the recommendation that such publications be generously illustrated. A carefully chosen, significant cut on the outside cover page of such a pamphlet secures for it a favorable impression before it is perused, and nearly always insures its being read. Abundant and good illustrations should also be scattered through the body of the pamphlet. The contents of the bulletin must, of course, depend upon the studies of the writer, but every entomologist has many lines of work open to him, and he should remember in making his selection that some of these will yield immediate and valuable results to his constitutents, while other questions equally easy to choose, and equally important, considered from the

standpoint of the monetary values involved, may be far more baffling of solution, and may require long periods of observation and research to obtain any sort of satisfactory results—in fact, they may be incapable of satisfactory solution at all. No one thing has done more to strengthen the Entomological Department of the Ohio Station with its constituency than its work in spraying apples. The methods employed were largely transplanted from the states of the Far West, being chiefly adaptations of the methods first strongly emphasized by Dr. E. D. Ball, but these methods would not have been generally adopted or used to any considerable extent for a long time if the Experiment Station had not tested their value and adaptability to Ohio conditions. Because of his service to the state in thus giving a great impetus to the resurrection of the fruit-growing industry, the entomologist has gained such financial support that he has been enabled to direct the leisurely investigation of some of the more difficult and abstruse problems, the results of which, considered by themselves, would have brought him very meager support, comparatively speaking. It often happens that after years of faithful and conscientious work on an injurious insect, the investigator can do but little more than give a full account of its history, habits, instars, etc., confessing that adequate remedial measures have not been found. While such work is valuable and must be done, the wise director of research will so distribute his effort that part of it is likely to produce strikingly successful economic results, part of it will be given to important questions that do not seem to hold out any immediate promise of successful solution, and another part of it can be devoted to the strictly technical work which interests only the professional entomologist.

If the most promising fields of work are neglected, no amount of faithful plodding or persistence in trying to solve more difficult problems will secure for the Agricultural Experiment Station Department of Entomology the standing with its constituents that can be obtained from doing well some important piece of work that contributes directly and obviously to their pocket books. So far as the public is concerned, it does not matter so much whether the work is entirely new and original or whether it is largely demonstrational in character. Where demonstrational work is provided for through other agencies than the Experiment Station, more time is, of course, left to the station entomologists for original research, and it is desirable that a considerable part of their time be left for this purpose; but in my opinion there is always likely to be sufficient material for original observation in any large-scale demonstrational experiment to justify the required outlay of time and money to accomplish it, aside from considering the increased prestige gained for the department.

This increased prestige often leads to such increased support that instead of being a handicap to research, as appeared probable when the work was commenced, it becomes a means of distinctly furthering original research. The chief point is that he who would go before the public with a message of any sort, whether it be original or merely demonstrational, must have a message that the people understand and which touches their welfare. They would far rather be taught how to utilize old knowledge that is of great value to them, than to be given tedious and unimportant information that is entirely new. The support they give will be proportional to the benefit *which they think they have received*. Demonstration meetings are very useful for arousing interest. A good discussion of the value of these is given by Prof. Franklin Sherman in No. 5, Vol. 2, of the JOURNAL of ECONOMIC ENTOMOLOGY. In Ohio we have made use of about the same methods as Professor Sherman in conducting spraying demonstrations. The railway companies are generally glad to distribute advertising matter along their lines and to put up posters in their depots throughout the territory that is likely to furnish excursionists to the demonstration orchards. Considerably more important than spraying demonstrations have been our field meetings to study results of the season's work. The first of these was held in the Schmitkons orchard in the fall of 1907. The results of spraying in this orchard are set forth in Bulletin 191 of the Ohio Station. Besides a detailed explanation of how the spraying had been done on the different plots, illustrated by a spraying outfit in action, water being used for the liquid, a diversified program was prepared covering several phases of orcharding. The station horticulturist was present and gave a lecture on pruning and culture of the orchard, the station botanist gave a lecture on orchard diseases, and a practical orchardist gave an address on marketing and packing.

All of the arrangements were made by the State Horticultural Society, and so successful was the meeting that it was decided to have an annual field meeting of the society each fall at some place where practical lessons could be learned. The same general plan in regard to program has been followed at subsequent meetings and while these have not always been held in orchards that were in charge of the Entomological Department, entomological topics have always had a place on the program. They have generally been held in an orchard which was for the season in charge of some one of the station departments, but in some cases have been taken to the orchard of some expert fruit-grower who was able to teach valuable lessons from his orchards and his fruit-growing methods. The present autumn, the field meeting was held at the Station orchards at Wooster. These

were all used during the season by the Department of Entomology for spraying experiments in which the effects of the different combinations of sprays such as lime-sulfur and arsenate of lead, and bordeaux mixture and arsenate of lead in different proportions were shown on foliage and fruit. At an earlier date, about midsummer, all the farmers' institute speakers employed by the state assembled in a convention were conducted through the same orchards and explanations were given of the work being done and the treatment that had been given to the different plots. The reports of these autumn field meetings of the Ohio Horticultural Society have been printed and distributed as circulars of the Ohio Station. A good idea of what is done at these field meetings and the nature of the papers or off-hand talks presented, can be obtained by consulting Circulars 87 and 103 which contain quite full details.

The farmers' institute also furnishes a method for reaching a good many people. It often happens that a man will read with interest a bulletin, the author of which is personally known to him, when it would hardly be noticed if the writer were a stranger. There is a limit, however, to the amount of institute work that can be done by the research student, and it is generally necessary to discourage calls of this kind rather than try to multiply them. At the Ohio Station we print a folder each fall which contains the following introductory paragraph:

> The members of the Station Staff named below are prepared to assist at a limited number of independent farmers' institutes and similar meetings. No *per diem* is charged for this service, but it is expected that the speakers will be reimbursed for their necessary traveling and hotel expenses.
>
> Where two or more names are given at the head of a list of topics requests may be made for discussion of any of the topics on the list by any member of the department. The lecturer requested will be sent if possible, but if conflicting engagements make this impossible, some other person qualified to discuss the subject will be sent.

At the head of the list of entomological topics we print the names of the entire entomological staff as far as they are available for such work, thus:

DEPARTMENT OF ENTOMOLOGY

H. A. GOSSARD.
W. H. GOODWIN.
R. D. WHITMARSH.

1. How to spray the apple orchard. (In some of our experiments the net returns have averaged $400 and $500 per acre for a single crop.)
2. How to spray peach, pear and plum orchards.
3. How to treat the vineyard to prevent Grapeberry worm and other insect enemies of the grape.
4. Home-made sprays, commercial insecticides and spraying machinery.
5. Our allies in the war against insects; birds, insectivorous animals, parasites, fungous and bacterial diseases.

6. Insects injurious to stored grain and how to prevent injury.
7. Insects injurious to cereal grains.
8. Insects injurious to forage crops.
9. Insects injurious to garden crops.
10. Insects injurious to potatoes.
11. Insects injurious to shade and ornamental trees.
12. Insects injurious to livestock.
13. How to treat San José scale.
14. How to treat the Fruit Bark Beetle and other borers.
15. Wonders of the Insect World (40 minutes night stereopticon lecture, many slides in natural color.)
16. Some birds and small animals, good and bad; their habits and value (40 minutes, night stereopticon lecture, several colored slides.)
17. Relation of insects to human welfare (40 minutes, night, by H. A. Gossard.)
18. Spraying machinery (40 minutes night stereopticon lecture, by W. H. Goodwin.
19. Any entomological topic not listed will be discussed if request for the same is made two weeks before the institute.

In our experience, simple talking without any illustrative material is not satisfactory. We have several ways for illustrating our lectures. For day lectures we make much use of enlarged bromide pictures. Life histories of insects, character of damage wrought by them, comparative results of treatment, different types of insecticidal machinery, etc., are quite susceptible to this kind of illustration. We use pasteboard mounting cards about 20 x 24 inches, or larger, so they easily take plates 16 x 20. These will carry illustrations sufficiently large to be seen readily by all the members of an average institute audience of 100 to 500 people. To economize weight we sometimes put a plate on each side of the board and sometimes we mount the plates on sheets of cloth instead of board. To carry these illustrations we wrap them in a cover of oilcloth and put a shawl strap about them. The lithographic chart recently prepared by Prof. F. L. Washburn of Minnesota for use in the schools of his state seemed so well adapted for institute work that I have had this backed with cloth and expect to make more or less use of it in giving the introductory lecture at institutes. Our Ohio institutes are usually for two days, and each worker is generally expected to give four and sometimes as many as six lectures during the session. For evening lectures we make much use of the stereopticon. The Bausch and Lomb Optical Co. have built a portable lantern according to specifications furnished them by our Messrs. Houser and Goodwin which can be mounted on an ordinary camera tripod and the entire machine with accessories, excepting the slides, can be packed in an ordinary suit case and weigh, when packed, but little more than thirty pounds.

We use an alco-lite attachment with this machine and find it quite satisfactory. We have also an electric lantern which we use in build-

ings that are wired and supplied with electricity and where exceptionally large audiences are expected, but this machine is altogether too heavy for general use. We have several hundred lantern slides, three or four hundred having been chosen from the Slingerland list and we have made about as many of our own. We have just as many as possible of these in natural colors and arrange them so as to give a connected and logical lecture. The first slide is generally the one which shows the division of insects into two groups, those with sucking and those with biting mouth-parts, then a series illustrating complete and incomplete metamorphosis is shown, then slides illustrating fecundity, parasitism, predaceous forms, the work of bacterial and entomophilus diseases, the functions of birds and insectivorous animals, mimicry, etc. After this introductory matter, special consideration is given to such insects as are apt to be of most local interest or which illustrate the day lectures. Some of the finest, most beautiful, and surprising slides are always reserved for the close of the lecture. Topic 16 has been added to give a wider range of choice and to accommodate audiences which in preceding seasons have heard No. 15. Mr. Slingerland has prepared many of the bird slides for us and we have made a good many ourselves. Besides birds, the rabbit, the rat, the skunk, the mole, the shrew, the woodchuck and the toad are considered. The natural history of these is discussed in more or less detail and suggestions for control or propagation are furnished. Many insect slides are worked into this lecture to illustrate the food habits of birds. Topic No. 17 is the article published in No. 5, Vol. 2, JOURNAL OF ECONOMIC ENTOMOLOGY. This is a somewhat heavy lecture for the average audience and though generally well received, I doubt if it leaves so lasting an impression as the stereopticon lectures and I know it is not so popular. The evening lecture by Mr. Goodwin on "Spraying Machinery" is very practical and is generously illustrated with a splendid set of slides of our own making, but we have not yet had time to determine whether or not there will be much call for it. The county schools of agriculture lasting from one to two weeks each, also offer an opportunity for giving short courses in entomology, and will, doubtless, supplant the farmers' institutes in time. These are comparatively new developments in Ohio agricultural education, and we have thus far had little opportunity to test their possibilities for entomological instruction. The horticultural and agricultural train offer some opportunities for scattering information, but thus far, we have not tried to utilize this method of propaganda. I believe Mr. Shaw of our state department of Agriculture and the Department of Agricultural Extention at our state university have used it with considerable success.

The midwinter Ohio Apple Show at Columbus, held in conjunction with the annual meeting of the State Horticultural Society, affords an opportunity of which we are glad to avail ourselves to exhibit our spraying results to the public. We purchase whatever apples are necessary from the orchardists, with whom we coöperate, to show the results of spraying upon insects, the effects of different sprays in causing russeting, etc. Our State Horticultural Society always expects a report from the station entomologist, and from the state inspector of nurseries and orchards as well, upon the observations and results of the year's work.

The agricultural newspaper furnishes an easy means for exploiting station work, but I am obliged to confess that I have utilized it far less than I should have done for this purpose. While I have occasionally volunteered an article for the *Ohio Farmer* and for other agricultural papers printed in the state, I have, for the most part, confined myself to answering such questions as were submitted to me by the editors with the request that I answer them. As between too much or too little publicity through newspaper writing, I believe too little is preferable, but am satisfied that I would help more people if I contributed at least one good practical article each month. One disadvantage about too much publicity, especially of the kind gained through newspaper writing, is that departmental correspondence is apt to become too burdensome and encroach too much upon the time of the staff. We are now obliged to anwer from 5,000 to 7,000 entomological queries per year at the Ohio Station and we almost wish it were unnecessary to ever increase the number. I am now asking the Legislature for the means to hire a clerk who can be trained to answer a large fraction of these without consulting the entomologists except to make certain the identification of insects. To enable him to do this the more readily, we expect to prepare short printed accounts of the life histories and habits of the more important economic insects with recommendations for treatment against the same. I am satisfied that this will be more satisfactory to all parties than our present method and at the same time, cheaper than sending out a bulletin or circular in answer to each inquiry. In whatever way such inquiries are answered, enough of detail must be given to enable the inquirer to obtain a complete answer to all the questions he had asked and besides these, to all that he ought to have asked. If this care is taken to inform inquirers, the correspondence of the entomologist will increase fully as fast as is desirable, and I sometimes think faster. I keep small slips just large enough to fit into our letter envelopes, having printed directions on each for making one of the various sprays, for using poisoned bait for cutworms, for treating cabbage worms, for

combating the striped cucumber beetle, etc.; others giving the addresses of manufacturers of spraying machinery and of insecticides and such other information as is most frequently asked for. This saves much time in dictating letters and an extension of the plan would enable a bright clerk to take care of much of the correspondence without much help.

The time has long since gone by when the station entomologist can quietly remain at his office headquarters and prosecute his researches without interruption by his constitutents. Today they wish to know what he has done and what he is doing and it is apt to be his own fault if they do not value his advice as highly as they do that of other agricultural experts in different fields of endeavor. Upon his good sense and cleverness in presenting results that are worth presenting, will depend the continuance of the public favor toward entomological activities, now so happily achieved and held.

SPRAYING FOR THE EUONYMUS SCALE

By Z. P. METCALF, *Assistant Entomologist, State Department of Agriculture, Raleigh, N. C.*

The euonymus is one of the most desirable hedge plants grown in North Carolina. It is evergreen, hardy, and with the exception of the euonymus scale seems to be free from diseases. This insect, however, is so destructive that what were once beautiful hedges are now reduced to scraggly clumps or the entire hedge has been cut down and removed.

During the summer of 1909, what had once been a magnificent hedge was turned over to us for experimental purposes. This hedge consisted of about one thousand feet averaging four and one-half feet high, and about two feet wide. This together with ten large clumps averaging thirty feet in diameter and twenty to twenty-five feet in height gave us an excellent chance to try out practical remedies. The hedge was in varying degrees of infestation. In fact, about three hundred feet of the hedge was so far gone that it was thought best to cut it down and reset with young hedge. About 90 per cent of the plants in the portion removed were dead, the remainder were very nearly dead. On July 16, 1909, kerosene emulsion, prepared in the usual manner, at the strengths of 15, 20 and 30 per cent oil was used on three different clumps of euonymus separate from the main hedge. All three clumps were badly infested. These clumps were inspected on July 23. At this time it was found that the 15 per cent kerosene emulsion had done very little good,—certainly not more than 10 per

cent of the scale were killed. The clump sprayed with 20 per cent kerosene emulsion showed, on an average, about 75 per cent killed. The clump sprayed with 30 per cent showed an average of about 90 per cent killed. None of the plants showed any injury whatsoever from the application of the spray mixture. It was, therefore, determined to spray additional clumps. On July 29 seven additional clumps, together with those originally sprayed, were sprayed with 30 per cent kerosene emulsion. This was repeated on August 11. On both dates the sun shone brightly all the time the spraying was going on and it was exceptionally hot, even for that season of the year. These clumps were examined on March 4 and it was found that about 95 per cent of the scale were killed on the clumps which had received two spraying with 30 per cent kerosene emulsion. The results were no better than this on the clump which had received one spraying of 15 per cent kerosene emulsion and two sprayings with 30 per cent kerosene emulsion. The clump which had received one spraying with 20 per cent and two sprayings with 30 per cent showed about 98 per cent of the scale killed. The clump which had received three sprayings with 30 per cent kerosene emulsion seemed to be practically free from scale and although it received no subsequent sprayings it remained free from scale, and was one of the most beautiful clumps on the lawn when last inspected on September 9, 1910.

On March 4 a new series of experiments was started. Six sections of the main part of the hedge, measuring about thirty feet each, were sprayed with the following mixture: Commercial lime-sulphur, 1 to 10 and 1 to 15. Scalecide, 1 to 10 and 1 to 15. Kerosene emulsion, 40 per cent and 60 per cent oil. These sections were examined on June 3, when it was found that none of the hedge had been injured by any of the mixture. Arranged according to their relative effectiveness they would rank about as follows: Scalecide, 1 to 10; kerosene emulsion; 60 per cent, scalecide, 1 to 15; kerosene emulsion, 40 per cent, lime-sulphur, 1 to 10; lime-sulphur 1 to 15.

On June 3 additional sections of the hedge were sprayed. Half of each of the blocks sprayed with scalecide on March 4 were sprayed with scalecide, 1 to 35. In addition ninety feet, which had not been previously sprayed, was gone over with scalecide 1 to 35 and sixty feet with scalecide, 1 to 25. Half of each of the sections which had been sprayed with lime-sulphur on March 4 were sprayed with lime-sulphur, 1 to 30. In addition two blocks of 150 feet each were sprayed with commercial lime-sulphur at 1 to 20 and 1 to 30. Half of each of the blocks which had been sprayed with kerosene emulsion on March 4 were sprayed with 30 per cent kerosene emulsion. In addition fifty feet of the unsprayed portion was sprayed with 30 per cent kerosene

emulsion as well as the seven large clumps on the lawn which had received only two sprayings previously.

The entire hedge was examined carefully, on September 9 the unsprayed portions were practically all dead. The portions sprayed showed varying degrees of infestation, from almost perfectly clean hedge to that which had been but slightly benefited. Taking into consideration the relative original infestation one was able to judge very accurately the relative merits of the different solutions used, as well as the benefits to be derived from sprayings applied at different seasons of the year. As far as we were able to judge there was very little difference between winter applications of strong solutions and summer applications of the same solutions used at weaker strengths. The best results seemed to be obtained by making one application of the stronger solution in the winter time and two of the weaker in the summer time until the scale is under control. After the scale is once thoroughly under control, we believe it can be held in check by one summer or one winter spraying each year, using either a soluble oil or kerosene emulsion. Our results would lead us to believe that early March, early June and early August are desirable times to make these sprayings under the climatic conditions of North Carolina.

Of the three materials tried, scalecide, 1 to 10 in winter and 1 to 25 in summer, would rank the highest. Next to this we would place kerosene emulsion, 60 per cent in winter and 30 per cent in summer. Either one of these materials seems to be an effective remedy for the euonymus scale. Our experience goes to show that these strengths may be used without any danger of injuring the plant. Commercial lime-sulphur did not prove to be an effective remedy in any of the strengths used. Although the hedge sprayed with commercial lime-sulphur showed decided improvement over no spraying at all.

Not the least important fact derived from these experiments to our mind, is that spray mixtures to be effective against this scale must be used at a much greater strength than heretofore recommended.

Brown-Tail Moth in Connecticut (*Euproctis chrysorrhœa* Fabr.).—The brown-tail moth was discovered in Thompson, Conn., in April, 1910, and later in Putnam. At Thompson several fruit trees found to be infested were sprayed with lead arsenate during May, and at the present time very few nests are found in that locality. The infestation at Putnam was discovered too late for spraying, and the nests were quite abundant on fruit trees in the city back yards. Scattering nests were found on trees three miles to the eastward, near the Rhode Island line. Local parties cut off and burned about five bushels of nests in Putnam, and later our state scouts went over the ground thoroughly and destroyed about 2,000 nests. The scouts are still working in Thompson at this writing, and though it is too early to generalize, it is probable that this infestation in the extreme northeast corner of Connecticut is the edge of the infested region extending through Massachusetts and Rhode Island, which has been close to the Connecticut line for at least two years. W. E. Britton.

Proceedings of the Ninth Annual Meeting of the American Association of Official Horticultural Inspectors

(*Continued from p. 129*)

Report of Committee on Treatment of Scale-infested Nurseries

The committee appointed at the Boston meeting of the Association to inquire into methods of dealing with nurseries infested with San José scale and to make specific suggestions pertaining thereto begs to report as follows:

As soon as the bulk of inspection work for 1910 was disposed of in our own states, the committee began an inquiry, sending letters to the proper authorities in each state as shown by the lists of the secretary of this Association.

In several instances no replies were received,—in one or two cases it was declined to discuss the matter,—in several cases merely the legal requirements of the state were mentioned without any description of the real methods of exact work done.

Your committee is glad to report, however, that a goodly number of satisfactory replies were received, for the most part from states where this work is of prime importance,—and in several instances hints or suggestions were given which we hope will be of interest.

The overwhelming testimony of the inspectors is in favor of the following genera scheme of treatment for nurseries infested with San José scale.

Treatment of Scale-infested Nurseries

1. A close general inspection to determine exact extent of infestation.
2. Every tree or plant actually seen to be infested destroyed.
3. Second inspection, if possible (tree by tree, if practicable) late in season or at digging time.
4. Fumigation of all stock remaining, after destroying all visibly infested trees.

In some states the fumigating is done by the inspectors,—in others the nurseryman signs an agreement or affidavit to do it and it is left to him,—in others it is required by law of all nurseries and left to them (with complete instructions) except in the worst cases, which are fumigated by the inspector.

Modifications practiced by different inspectors which are believed to make for better results are as follows:

1. In one state all cyanide is furnished through the inspector's office, thus insuring good, uniform grade and proper doses.
2. In one state it is required to spray all growing stock in nurseries where scale has been found with result that infestation is rendered less from year to year.
3. In one state a special form of certificate (stating that part of the stock *was* found infested), is issued to infested nurseries. No nurseryman would want such a certificate if he could possibly get a clean certificate.
4. One inspector destroys every plant found infested and all around it for a distance of twenty to thirty feet.
5. In one state all inspections after the first are charged for, the fee based on infested acreage involved,—so a nurseryman seeks to avoid more than the one regular inspection, which is free. In another state where second visit is needed or fumigation done by inspector, the whole expense is charged to the nurseryman.
6. Some states withhold the certificate until all the work of the inspectors has been completed.

It is usual to permit sales from infested blocks,—but only after all visibly infested trees are destroyed, and after fumigation (by nurseryman or inspector) of all the others. The making of tree by tree inspection and then *not* requiring fumigation is followed by one inspector with small nurseries, but fumigation is required of those doing a large trade. The fumigation, and later selling, of trees known to be infested has been permitted on some occasions in one state. Such concessions, which might appear dangerous, are usually in cases where the stock is destined for localities already infested and where the purchasers do not care whether it is infested or not, as it will be watched and sprayed anyway.

It is suggested that much would be gained if the fumigation of all buds, scions, etc., brought into the nursery could be secured,—but it is obviously difficult to enforce this. Intelligent and careful nurserymen might gladly adopt the suggestion.

From one state comes the suggestion for central quarantine stations where all entering stock should be inspected.

But it must be recognized in all work that the degree of thoroughness and exactness varies with the character of the man who inspects, and the character of the nurseryman. The time, money and force available for the work are also factors which cannot be eliminated. An inspector working alone, who has limited funds and time will readily make every possible concession to a conscientious nurseryman,—while an inspector with ample funds and time to look after details may be very exacting with a nurseryman whom he distrusts. We find that everywhere this human element enters,—and in no state, even with the most explicit laws, do we believe that it can be or should be eliminated. Flexibility, with much left to the discretion of a competent and conscientious inspector, seems to be one of the desirable points which is sought for everywhere.

FRANKLIN SHERMAN, JR., *Chairman.*

RALEIGH, N. C., December 23, 1910.

The report of the committee was received and the committee continued for the purpose of extending its investigations, so that a proper system of treatment can be outlined by the Association.

PRESIDENT WASHBURN: The next on the program is a paper "A Practical Method of Inspecting Imported Seedlings" by Mr. Symons of College Park, Maryland.

A PRACTICAL METHOD OF INSPECTING IMPORTED SEEDLINGS

By THOMAS B. SYMONS, *College Park, Md.*

The question of properly inspecting the large amount of imported trees, plants, seedlings, etc., that are now received annually in our several Eastern States particularly, and, in fact, throughout the country, due to finding the hibernating stages of the brown-tail and gypsy moths, as well as other pests, is one that has taxed the resources of state inspectors who are provided with limited funds for such work.

Indeed, I am frank to admit that I was ignorant until the past two years of the large amount of such stock that is imported into this country With a view of stimulating a discussion of the methods employed by the different inspectors and to show how this work is being handled in Maryland, this brief paper is presented.

Amount of Stock Imported

During the last spring the following approximate amounts and character of stock was imported by persons in Maryland:

2,302,300 French fruit stocks.
754,417 Holland fruit stocks.
149,325 Holland Ornamentals.
10,000 French Ornamentals.
Total, 3,216,042 seedlings, plants, trees, etc.

This does not include a quantity of herbaceous and florists' stock that was also imported. However, until this fall no attempt has been made to inspect some classes of this stock. As is quite general, I presume, the large majority of this stock is imported by nurserymen and wholesale dealers. Moreover, the bulk of the inspection has been up to this time seedlings of apple or allied plants.

In making arrangements for this inspection it was first thought best to employ the local inspectors and send a gang of ten to twenty to a place to go over carefully the large shipments of seedlings that were being received by different parties in the state. Upon a further consideration of the case, after consultation with the importers, it was found that the usual practice of growers was to carefully handle the seedlings, trimming both ends, and either place them in sand for a time or plant them in the field immediately. It was also learned that the seedlings should be handled as little as possible as exposure to air or added moisture would cause opposite but unfavorable conditions. The nurserymen desired that the seedlings be handled but once, if possible. The question to be decided was one of practicability *versus* theory. Whether we should inspect the seedlings by a score of inspectors at great expense, encountering the difficulties attending such operation, especially the unfavorable conditions of inspecting the seedlings when more or less packing was attached to them and placing them back in boxes, or to inspect the seedlings after the nurserymen had pursued their usual course in handling the trimming and preparing for healing in sand. Especially did the latter method appeal to me as it was decidedly the most economical and, I think, more effective. Our present method of inspecting large quantities of seedlings is as follows:

The nurserymen or grower provides a clean space in a packing shed and his force of men are put to work trimming the seedlings. These men are under the supervision of a personal assistant from the office who inspects all the seedlings after they have been trimmed. Instructions are given all the men to pull off all old leaves or anything that is attached to the individual seedlings. All found bearing a nest of brown-tail moth or other suspicious cocoon or egg mass are thrown out and destroyed by the inspector immediately. All packing is also destroyed and boxes properly treated by the inspector. Every precaution is taken to keep everything of a waste character in the given space, so that no opportunity is given for anything to escape. One inspector can carefully examine seedlings from thirty or forty men after they have been put in a convenient shape for handling.

Thus one man has been able to properly care for the inspection of an enormous amount of stock at one place. The inspection has not interferred with the routine of nursery work, and the whole has been taken care of at a minimum cost.

One of our greatest difficulties is the proper inspection of consignments to department stores, auctioneers, etc. During the past year a quantity of miscellaneous ornamental stock has been received by such parties in Baltimore. In such cases the conditions are not as favorable for thorough work as at the nurseries. It is a question if such stock consigned to parties in the immediate vicinity should not be inspected at a quarantine station.

In performing our duty as state inspectors I believe we should stand firm on our requirements, for the best interests of all concerned, but I believe we should be as practical as possible in devising methods so that such provisions may be successfully carried out.

We must maintain the confidence and coöperation of both the grower and nurseryman. Nothing will so easily dispel this confidence or lessen a coöperative spirit among growers than lack of efficiency in work undertaken due to impractical or costly methods of procedure.

PRESIDENT WASHBURN: The chair would like to ask Mr. Symons what precautions are taken regarding the cuttings or trimmings before the inspector takes hold of the work.

MR. SYMONS: Nothing is done until the Inspector arrives.

Mr. BURGESS: I would like to ask Professor Symons what is the method of handling the consignments that go to the auctioneers.

Mr. SYMONS: Up to the present time it has been a rather ineffective form of inspection. Practically all of this stock has come from Holland, and in our experience, we have never found anything on Holland stock.

SECRETARY SYMONS: I would like to ask Mr. Atwood what is his manner of procedure in inspecting stock in New York.

MR. ATWOOD: The trees are overhauled, and if the stock is open we are expected to give thorough examination. The nurserymen are required to bring the stock up and put it on tables where the inspectors can see the whole thing. The stocks, roots and packing are examined for brown-tails, and for detached portions. In taking a bundle from a box it is very easy for some of the infested material to be left in the packing, we burn the packing from a box wherever a brown-tail nest has been found; or, in the case of the cast skins of the gypsy moth, we require that the packing material and the box also be burned.

SECRETARY SYMONS: Do you inspect the seedlings before they are trimmed?

MR. ATWOOD: The nurserymen have been required to dip them in miscible oil, either before or after, depending on conditions. Some of our largest importers will distribute boxes among their plantations, and they have to be examined there, and we have to move around rapidly enough to cover the ground. The inspector insists on anything that will facilitate inspection. If a large quantity of seedlings are to be handled, and the room is large enough they are spread out on tables. I think your method of handling large quantities under favorable conditions is most excellent, and you ought to accomplish the result of letting no pest get by you. Your paper is excellent, and the method suggested is good where you can do that, but suppose you go to a nursery where the proprietor has eight or ten boxes in a dark cellar, and the man has no place to unpack indoors, and the weather is too cold to do it outside, you have to do the best you can. I think our inspectors are not inclined to be easy with any one who wants to cover up anything.

SECRETARY SYMONS: I understand that a great many states inspect seedlings prior to trimming. In regard to the case you mention where the stock is not in a convenient place for inspection, or it is too cold to inspect it outside, would it not be better to wait until the nurseryman is ready to handle the seedlings, rather than make him go to the trouble and expense and possibly subject the seedlings to unfavorable conditions?

MR. ATWOOD: I think it is the pruning of the seedlings that has kept us from the brown-tail moth. Years ago, before we had heard of inspection, the hands were told that any insect should be destroyed.

MR. SUMMERS: I have been forced, because of lack of funds, in practically the same manner Professor Symons speaks of, to try to impress on our nurserymen, chiefly the shippers, the necessity of being very careful. They are extremely anxious not to let any brown-tail

moth get by them, because they do not want it on their own stock, and more particularly because they do not want it on the larger amount of stock which they ship out. Our most reliable nursery last year placed two men as supervisors over their trimmers and graders. They were talked to by the importer and by myself. The proprietor urged upon them the absolute necessity of care, and the two men, his own most careful foreman, were given to understand that nothing must get by them. I had an inspector myself on the ground, and one brown-tail nest got past them all. The trimmings were cleaned up thoroughly and burned every day.

PRESIDENT WASHBURN: Do you think it is perfectly safe to let the nurserymen trim before they are inspected?

MR. SUMMERS: I thought it was better to do so. The brown-tail did get by them in two cases; one was a shipment into Illinois; the other one was found after the seedlings had been set out the next spring. We have adopted the policy of going over all seedlings as soon as possible after they are set out.

MR. ENGLE: These conditions differ somewhat from those in my state. There are two of us that inspect. All bundles were opened in our presence and gone over, and passed on to another set of men, who tied them up and took them away, and no trimming was done whatever. Every package was opened and examined, except such varieties as were practically all roots, which we did not open.

THE PRACTICABILITY OF NURSERY QUARANTINE STATIONS

By A. F. CONRADI, *Clemson College, S. C.*

For a number of years we have had laws in the various states to govern interstate shipments of nursery stock. The object of these laws is to protect the respective states against the introduction of certain injurious insects and plant diseases. The laws of most states closely resemble each other as far as the provisions contained therein are concerned, though the rules and regulations governing the various inspectors, vary to some extent.

A mere law is not much of a protection unless the act and the rules and regulations give wide latidude to the inspectors. The efficiency of a law is mostly governed by the inspection force. The writer has found badly infested stock bearing a certificate signed by one of the most conscientious and one of the oldest entomologists in this country. It was never inferred that this was a blunder on the part of that entomologist. It is merely assumed and without hesitation that the official whose name appeared on the certificate had never seen the stock.

Though this consignment was fully covered with the necessary tags and certificates, yet it was so badly infested that the infestation was in evidence by merely glancing at the shipment. This occurred some years ago. Minor cases are coming to our attention from time to time. It is especially discouraging when these shipments are sent into sections of the state where considerable effort has been put forth to eradicate scale.

In South Carolina we have worked hard to eradicate scale from the state and in several instances we have confiscated or returned shipments found at railroad stations. These shipments were properly covered with tags and certificates, but these were certainly no protection to us. It is merely a question as to how frequently such consignments are shipped,—not only into South Carolina, but into other states as well, but which are never seen until the trees have been planted. Of course in a state where a large inspection force is active the number of chances for such stock to reach destination are reduced, but a number of states have not an inspection force sufficiently strong to keep close enough vigilance throughout the state.

Our inspection laws have no value in protecting us against our reliable nurserymen. We need no such protection. They will ship to us nothing but clean and sound stock. It is easy to see for whom these laws are made. Do they serve that purpose sufficiently well?

The writer, with the view of overcoming this difficulty, has for some time advocated the establishment of receiving stations for nursery stock within this state. Such stations may be located in convenient sections and a law passed that all stock coming into the state be shipped to one or another of these stations where the inspector has an opportunity to inspect the same. At any rate the inspection office would then have a method by which stock coming into this state could be checked and recorded.

Under what conditions would such stations be constitutional and would they be practical? The first is a question to be answered by the courts. The writer believes that under certain conditions as those described below that such stations could be economically and efficiently operated. Take South Carolina for example. The main office is at Clemson College in the northwestern part of the state. One entomological field laboratory is located at Marion in the eastern part of the state, another laboratory operating part of the time near Charleston in the southern part of the state. While the second field laboratory is not permanent, it is hoped to make it so. We would then have three convenient locations for such stations.

The amount of nursery stock shipped into South Carolina is not overwhelming and with the present amount of interstate trade, it

would not be very difficult to handle them at such receiving stations. Even where a tremendous amount of stock is shipped into the state, it would not always be necessary to handle every shipment. The inspection office makes as close a study as possible of all outside nurseries, doing business in the state, and these offices are generally well informed as to the reliability of the various nurseries. This information is a very convenient guide in handling interstate shipments. Instead of establishing quarantine stations, were the law amended so that every citizen would be required to notify the state inspection office every time a shipment of nursery stock had arrived, the visiting of the different places throughout the year would no doubt involve a greater expense and loss of time than a system of receiving stations where all stock is systematically inspected. The former would necessitate the employment of county or district inspectors in order to carry it out effectively.

These are merely suggestions. It is difficult to foretell what the efficiency of such a system would be without carrying out the experiment. These suggestions are not intended to burden our reliable and conscientious nurserymen but they are intended for all unscrupulous nursery dealers.

RESULTS OF EXPERIMENTS ON DIPPING TREES AND FUMIGATING PEACH BUDS

By T. B. Symons and E. N. Cory, *College Park, Md.*

[Withdrawn for publication elsewhere.]

Mr. Headlee: I wish to say that in connection with our work against mill insects, extended tests made to determine the formula, which would give the maximum amount of gas in the minimum time, indicated that the one now recommended by the Department of Agriculture (1–1–3) is best.

THE HEALTH OF PLANTS AS RELATED TO INSECTS

By J. B. S. Norton, *College Park, Md.*

The influence of insects upon plant health is enormous, as is witnessed by the great expenditure of time and money on economic entomology which is devoted mostly to protecting plants against this division of the animal kingdom. In this land of specialization the development of this branch of plant pathology by men specially interested in the insect has, as in the branch of fungous diseases developed

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by mycologists, led away from the disease itself to the more thorough study of the causative organisms.

I wish to consider in the following paper the effect of insects upon the plant rather from the standpoint of plant health, than from the standpoint of the insect or of the entomologist, and in my judgment this would be the true attitude of the economic entomologist who wished to build his science upon the firmest foundation.

The action of insects upon plants may (1) directly impair the health of the plants, and may be considered under the head of (1) simple injuries, and (2) definite diseases which follow as a result of insect injuries or the presence of insects or their products in the plant tissues; or their action may be (2) indirect in that they actually introduce fungi or bacteria which cause disease, or these organisms may enter through the openings in the epidermis made by insects.

I. Direct Injuries

The chief effect of insects is the actual destruction of plant parts in the process of feeding, nest building or oviposition. While the loss of many organs is not so serious as with animals, owing to the great number of structures having the same function in most plants, growth and production is greatly reduced by the enormous losses on the whole, as, for example, in the reduction of carbon assimilating surface when such insects as army worms and other caterpillars, potato bugs, grasshoppers, etc., feed upon the foliage. Reproduction is interfered with through seed destruction by such insects as grain weevils, Angumois grain moth, wire worm, wheat midge; the embryo may be actually destroyed or the stored food removed so its growth is impaired. Reproduction is also interfered with at an earlier stage by insects such as the corn worm when feeding upon the silks and pollen. While codling moth and cotton boll-weevil interfere some with the reproductive organs, they are chiefly feared for the havoc they work to products of more use to man than to the plant.

Another form of injury is where the material for growth is removed by insects which suck out the plant juices, and while more serious trouble may occur at the point of attack the chief loss is in building material. The removal of material from the wood of stem or root may interfere with the mechanical stability of the plant and it breaks or is uprooted.

Physiological Troubles Following Injury

When plant roots or the woody stems have been destroyed by insects, wilting may follow from inability to secure water (*e. g.*, squash bug, bean vine borer, striped cucumber beetle) or if the damage is not

severe, a slow death indicated by red or yellow, stunted foliage and finally drying up of the leaf edges or whole leaf, due to reduction in water supply and salts from the soil. In cabbage lack of water stimulates the production of the bluish white bloom on the leaves which protects the leaf against loss of water; so this symptom may indicate root or stem injury by insects. Another means of protection against loss of water when roots are injured is for the plant to drop some of the leaves; and so leaf fall in summer may be a result of insect injury to the wood of stem or root.

In case the live bark is injured so that the plant is partly girdled, the downward flow of sap is interfered with and the parts below the wound may suffer for food while a swelling may form above where the nutrient material accumulates. The work of the bean vine borer is an example. A very interesting and well-illustrated account of interference with starch translocation from leaves, due to the work of leaf miners, has recently been published. (Centralb. Bakt. II, 24: 158.)

The destruction of the buds of plants by insects induces the production of branches out of the normal position and number and thus changes the habit of the plant, as in the case of plant bug injuries to dahlias, when there is a mass of leaves, roots and stems but no flowers, and the dwarfed greenish heads of wheat at the time they should be in bloom, due to another insect. I might class with these the scrubby growth of some pines, due to bud injury, and the crooked white pine trunks due to weevil borings; also the bending of the bean stem following work of the vine borer, and the curling of many leaves due to injury by insects on one side. Gummosis in peach and related trees follows the work of insects as it does any injury.

A serious trouble following defoliation by insects is the weakening of trees by the production of new crops of leaves to take the place of those lost. According to Britton two defoliations of elms in one season by the elm beetle will kill the trees.

Diseases Due to the Presence of Insects or Their Products

Under this head would come the multitude of galls formed by many different kinds of insects. But cecidology is a science in itself and having been studied more than some other branches of my subject I shall not go into it further. Whether insect presence stimulates the plant to excessive growth in gall formation I shall not attempt to say. A common example is woolly aphis galls, and erineum effect. Nematode root galls may be mentioned though hardly to be included among insect work.

I shall mention here some other troubles for want of knowledge to properly classify them anywhere: The darker green color, swelling at point of attack, and tendency to stool in wheat attacked by Hessian fly; the swelling and russeting of apples following the work of curculio; the suck fly injury to tobacco, which impairs its burning quality; leaf curl, due to leaf hoppers and thrips; stigmonose; red spots, due to San José scale, etc.

II. Diseases Indirectly Due to Insects

A large number of bacteria and fungi which induce disease in plants can enter the plant only through breaks in the protecting epidermis or bark. The large majority of such diseases enter through insect injuries, in many cases the insects actually carrying the infection on their mouth-parts.

Lindau, in volume two of the third edition of Sorauer's Pflanzenkrankheiten, gives references to the following diseases introduced by insects and other invertebrates:

Vuillemin believes the bacillus of the knot disease of *Pinus halepensis* to be introduced by insects.

The bacterial rot of hyacinths, etc., studied by Erwin Smith and Wakker, may be introduced through wounds made by insects.

It may be that some of the scab of potato is caused by *Euchutræids* (*Oligochæ'æ*) eating the surface of the tuber and the scab fungus afterwards occupying the injured surface.

Erwin Smith infected crucifiers with black rot by allowing *Agriolimax agrestis* to feed on leaves after being placed on pure cultures of the *Pseudomonas*. The larva of the cabbage butterfly is probably one of the chief means of introducing the bacteria in the field.

Waite has shown that the bacillus of pear blight is carried to the stigma, where the great majority of cases originate, from infected sap escaping from the bark in spring. The cases of blight on flowerless twigs may be introduced through insect punctures in the young bark.

Vuillemin thinks that the olive knot bacillus enters through the work of *Phytoptus fraxini* on ash trees.

The bacillus of potato rot is thought to be introduced by insects. Erwin Smith infected plants with *Bacillus solanacearum* by means of the Colorado beetle.

Earle considered the bacteria of point-rot of tomato to be introduced through small insect punctures and insecticides a better means of controlling the disease than fungicides.

Erwin Smith infected cucurbits with *Bacillus tracheiphilus*, the cause of wilt disease, by means of *Diabrotica vittata* and *Anasa tristis*

sprayed with the bacteria, and the destruction of these insects is recommended as a combative measure.

Rudow holds the infection of Prunus with Exoascus to be favored by the development of the fungus in the sugary secretion of plant lice.

J. Behrens thinks that insects carry the spores of *Nectria cinnabarina*. He noted that flies visited the fungus.

Descours Desacres observed that *Nectria ditissima*, associated with the canker of fruit trees in Europe, entered through the openings made by aphids, the same insect also transmitting the spores from one tree to another.

Noack observed that *Ophionectria coccicola*, a fungus living on scale insects in Florida and elsewhere, passed from the insect into the orange twigs and there caused a gummosis.

In the Sphacelia stage of the ergots a honey-like substance filled with the spores is produced. This is sought by *Melanostoma mellina*, *Rhagonycha fulva* and other insects, according to R. Stager, and by them introduced into young grass flowers.

A disease of sugar cane due to Trichosphæria studied by Massee, Prilleaux and Delacroix enters through the openings made by a beetle, *Xyleborus perforans*, the moth borer and the weevil borer, *Sphenophorus sericeus*.

Von Schrenk found that the wound parasite fungus *Ceratostomella pilifera*, causing the bluing of the wood of *Pinus ponderosa* entered through the borings of *Dendroctonus ponderosæ*.

A *Cucurbitaria* disease of trees is carried by snails that feed upon the stroma of the fungus.

In discussing the larch canker caused by *Dasyscypha*, a strictly wound parasite, Hartig mentions wounds made by *Coleophora laricella* and *Chermes laricis* as offering an entrance for the fungus. Also *Dasyscypha resinaria* enters spruce through the work of *Chermes abietis*.

The conidia of *Sclerotinia urnula* are carried to the flowers, of *Vaccinium vitis-idæa* by insects attracted by their fragrant smell according to Woronin. The same is true of other sclerotinias.

The sclerotinia of the brown rot of peach, etc., enters chiefly through the punctures of insects [chiefly curculio here].

The spores of smuts like *Ustilago violacea* which take the place of pollen in the anthers of flowers they attack may be carried from flower to flower by insects just as the pollen is.

According to von Schrenk the white rot fungus, *Fomes juniperinus* enters the red cedar through openings made by beetles.

The Phoma disease of cabbage is said to enter through wounded roots and insects are suspected. *Anthomyia brassicæ* is mentioned.

Macrophoma dalmatica probably attacks the olive through insect punctures.

The case of the mulberry disease caused by *Septoglœum mori* may be cited as an example of a plant disease with bad effect upon insects, as the diseased leaves are not used by the silkworms.

Botryosporium pulchrum attacks wheat weakened by *Tylenchus vastatrix* or otherwise.

Fusarium dianthi, according to Delacroix attacks Dianthus through wounds caused by mites, etc.

In addition I may mention the introduction of brown rot, black rot and other fungi into apples through codling moth injury; the decay of corn roots following the work of the corn root web worm mentioned by Sanderson; the rots of corn which are thought by Haslam to be the cause of blind staggers in horses and which enter through the injuries of the ear worm in the young ears; the entrance of early blight of potato through the flea beetle perforations.

In my work in 1896 on corn smut I found in testing different methods of infection, that puncturing of the young tissues after the beginning of ear and tassel formation was the most effective. Hitchcock later noted the increased amount of smut on detasseled corn. I am confident that under natural conditions the corn stalk borer will be found one of the chief agencies in corn smut infection.

The honey dew of plant lice and various scale insects furnish a medium for the growth of black fungi, which, while not parasitic, do damage by excluding light and air when they densely cover the foliage.

The flower-like fragrance of the spermogonia of rusts is attractive to insects and the spermatia are undoubtedly disseminated by them, but as this type of spore has but rarely been germinated, it is not known whether they may cause infection or not.

According to B. R. Bones of Racine, Wis., the cabbage rot germs are introduced by insects.

When the regular program had been disposed of, the following questions were taken up in order and discussed freely by the members:

QUESTIONS FOR DISCUSSION

1. The kind and form of information concerning individual nurseries to be furnished by an inspector to inspectors of other States.

2. What is the opinion of State inspectors regarding the sale of strawberry plants from districts known to be infested with the Strawberry Root Louse?

3. What is the best way to treat nursery stock infested with the San José Scale where such stock is to be planted in infested orchards or sections, the owners of which do not regard San José Scale infestation serious, they having adopted adequate spraying methods for its control?

4. Assuming that nurserymen may demand that their trees shall be treated for San José Scale instead of being destroyed, what formula for treatment should be employed?

5. Why does fumigation with Hydrocyanic Acid gas occasionally fail?

6. Will dipping nursery trees in lime-sulfur solution prove effective? If so, should roots be immersed?

7. What action should be taken by Horticultural Inspectors in reference to imported bulbs, herbaceous and greenhouse plants?

8. What progress has been made in barring wormy and scale infested fruits from the markets in different states?

9. Is it advisable to place upon the face of each certificate the number of acres represented?

10. Should not inspection of imported stock be made at ports of entry into this country, under federal supervision?

11. What is the best means within our reach to make sure that railroad companies are observing the law regarding the transportation of nursery stock without inspection certificate?

12. What is the present status of Crown Gall on Apple?
    a. Relation of Crown Gall and Hairy Root.
    b. Prevention of this disease in the nursery.
    c. Inspection and requirements for Crown Gall.
    d. Contagiousness.

The meeting stood adjourned at 5 p. m., Friday, December 30.

Another Breeding-place for the House-fly.—The material in which the House-fly is known to breed in greatest numbers is fresh horse-manure. But there are other substances which offer conditions of temperature and moisture that are as favorable, if not more so, and their scarcity alone prevents them being more than local factors in considering the control of this pest.

The writer made some observations on the breeding habits of the House-fly during September and October of 1910. Large amounts of alfalfa ensilage were being fed at the Kansas State Agricultural College dairy and what was not eaten by the cows was removed from the manger when cleaning the barn each day, and thrown into a manure spreader where it was left until a load had accumulated. Flies collected upon this waste ensilage in large numbers, and upon examination large masses of eggs—hundreds in a cluster—were found from one to two inches below the surface of the heap. A number of flies that were coming up from among the pieces of ensilage were caught, and they proved to be *Musca domestica*.

At first it was believed that the flies were attracted to the ensilage because it had been used as bedding and had become soaked with urine; but both eggs and maggots were found on chunks left in the manger from the last feeding. This led to an examination of the ensilage in the silo. Here the adult flies were numerous, and all stages of their life history were present. A handful of ensilage that the men in charge pronounced in excellent feeding condition was found to contain eggs and young larvæ. At the sides of the silo where decomposition had gone farther and the surface layers had not been removed so rapidly, grown larvæ and pupa were found.

Francis B. Milliken, B. S.,
Assistant Entomologist, Kansas State Experiment Station.

A NEW SPECIES OF COCCOPHAGUS WITH A TABLE OF THE HOST RELATIONS OF THOSE SPECIES OF THE GENUS KNOWN TO THE WRITER

By L. O. Howard

Coccophagus is a widespread and important internal parasite of certain scale-insects, and is practically confined to the non-Diaspinæ. Were it not for some of the extraordinary results of rearings carried on at the parasite laboratory at Melrose Highlands under the direction of Mr. W. F. Fiske and of others at the boll-weevil laboratory at Dallas under the direction of Mr. W. D. Hunter, I would state that the species of this genus are invariably primary parasites, but such statements as this in the light of these recent investigations must be more guarded. The probabilities, however, point towards invariable primary parasitism. The present species under consideration is the largest of the genus so far described and is quite distinct from its congeners.

Subfamily Aphelininæ Howard

Genus Coccophagus Westwood

Coccophagus albicoxa, n. sp. *Female.*—Length 2.6 mm., expanse 5.4 mm., greatest width of forewings 0.6 mm. General color shining black; apical half of mesoscutellum lemon-yellow with a central shade of the black descending somewhat into the yellow; all femora black; front and middle coxæ black, hind coxæ yellowish white; edge of metapleurum caudad of spiracle yellow; middle and hind tibiæ black, front tibiæ only dusky; front tarsi brownish; middle and hind tarsi light yellow; antennæ black, tip of pedicel brown. Mesonotum very faintly shagreened. Apical bristles of mesoscutellum very long; mesopleurum perfectly smooth, shining; abdomen smooth, shining, very faintly shagreened, much more faintly than mesonotum; wing veins dark brown; wings hyaline, iridescent. One female reared by H. J. Quayle from *Physokermes insignicola* received from Lampoc, California.

U. S. N. M. Type No. 12170.

The following table indicates the host relations of such species of the genus as are known to the writer:

Parasites	*Hosts*
Coccophagus lecanii Fitch	Lecanium quercitronis Fitch
	Lecanium quercifex Fitch
	Pulvinaria innumerabilis Rathv.
	Pulvinaria acericola (Walsh & Riley)
	Lecanium pruinosum Coq.
	Lecanium persicæ (Fab.)
	Lecanium on plum
	Phenacoccus aceris (Sign.)
	Coccus hesperidum Linn.
Coccophagus fraternus How.	Lecanium persicæ Fab.

Coccophagus cognatus How.	Coccus hesperidum Linn.
	Saissetia nigra (Nietn.)
	Lecanium sp. on plum
	Lecanium persicæ Fab.
Coccophagus immaculatus How.	Eriococcus azaleæ Comst.
	Pulvinaria bigeloviæ Ckll.
	Saissetia hemisphærica (Targ.)
Coccophagus flavifrons How.	Lecanium sp. on Pinus australis
Coccophagus flavoscutellum Ashm.	Coccus hesperidum Linn.
	Lecanium spp. from California
	Pseudococcus destructor Comst.
	Ceroplastes floridensis Comst.
	Lecanium tulipiferæ Cook.
	Pulvinaria on plum
	Pulvinaria on Sullengia
	Pulvinaria innumerabilis Rathv.
	Lecanium on plum
	Lecanium sp. on Adenostoma
	Lecanium sp. on Arctostaphylos
Coccophagus californicus How.	Lecanium armeniacum Craw.
	Icerya purchasi Mask.
Coccophagus lunulatus How.	Chrysomphalus aurantii (Mask.)
	Coccus hesperidum Linn.
	Saissetia oleæ (Bern.)
Coccophagus scutatus How.	Kermes sp. on Quercus agrifolia
	Kermes nigropunctatus Ehrh. & Ckll.
Coccophagus ochraceus How.	Lecanium sp. on Adenostoma fasciculatum
Coccophagus orientalis How.	Ceroplastes actiniformis Green
	Coccus viridis (Green)
	Saissetia hemispherica (Targ.)
	Pseudococcus longispinus Targ.
Coccophagus flavescens How.	Saissetia hemisphærica (Targ.)
Coccophagus fletcheri How.	Eulecanium fletcheri (Ckll.)
Coccophagus singuliventris Girault	Lecanium nigrofasciatum Perg.
Coccophagus subochraceus How.	Lecanium on Leucospermum
Coccophagus longifasciatus How.	Lecanium nigra (Nietn.)
Coccophagus howardi Masi	Philippia oleæ
	Ceroplastes rusci
Coccophagus niger Masi	Lichtensia viburni
Coccophagus albicoxa How.	Physokermes insignicola (Craw.)

The Rufous Scale at Key West, Florida.—In August, 1909, the writer collected citrus leaves at Key West, Florida, infested with a scale which, from a casual examination, was taken to be the California Red Scale (*Chrysomphalus aurantii* Mask.). Recently in looking over this material it was found that the insect is the Rufous-Scale (*Selenaspidus articulatus* Morg.). This citrus pest apparently has not been recorded heretofore from the United States. In the report of the Florida Agricultural Experiment Station for the fiscal year ending June 30, 1907, Dr. E. W. Berger presents a good half-tone illustration of a leaf infested by this insect and notes that it was sent to him for identification from St. Croix, Danish West Indies.

A. W. Morrill.

ATTITUDE OF THE NURSERYMAN TOWARD A NATIONAL INSPECTION AND QUARANTINE LAW

For the last fourteen years a strong effort has been made to secure national quarantine and inspection legislation, relating to imported plant stock. This effort has been blocked very largely by the opposition of a small body of importing nurserymen. The main body of nurserymen have interests identical with fruit growers, and seem to be generally in favor of protective legislation, and the *National Nurseryman*, the principal organ of the nurserymen in this country, has taken positive stand in favor of such legislation.

To obtain immediate legislation, to give the protection which is so much needed just now, it was agreed to modify the bill before Congress (H. R. 26897), to meet the final objection of the importing nurserymen, inasmuch as at the conference last winter with the House Committee on Agriculture, these nurserymen, through Mr. Pitkin, the chairman of their committee expressly stated that if their objections were met, they would join with the entomologists and fruit growers in urging the passage of this measure. It was arranged, therefore, that the quarantine provision of section 8 should be modified to apply specifically and solely to the "potato wart disease" which is likely to jeopardize our whole potato industry, and the "white pine blister rust" the European disease, which is the cause of great losses wherever it appears. Thus modified, the section does not touch the interests of the importers of nursery seedlings of fruit and ornamental stock, and it was confidently hoped and expected that the bill would become a law at the session just closed.

To get action at this session of Congress, it was necessary to bring the bill out of its regular order and place it on the Unanimous Consent Calendar, where the objection of one member prevents legislation. The Nursery bill came up on the 6th of February, and was objected to by a member apparently acting in behalf of the importing nurserymen, and went back to the regular calendar.

In the closing days of the session, the bill was again brought up on the Unanimous Consent Calendar. There was a brief discussion of it, chiefly participated in by the opponents of the measure and the motion to suspend the rules, and pass the bill was lost, the necessary two thirds not voting therefor, evidently largely through lack of appreciation by the house as a whole of the urgent need of the measure. (See *Congressional Record*, March 2, 1911, pages 4072–4076.)

This action of the nurserymen through their representatives in Congress is in exact accord with the previous behavior, as the following historical summary indicates. This summary is also interesting

as showing, through the reports obtained by Mr. Harrison, the actual attitude of the great body of nurserymen, other than importers, throughout the country.

Attitude of the Nurseryman as Shown by the Records

Numerous conferences, beginning in 1897, and ending in 1908, failed to secure any agreement with the nurserymen as to a national law, covering either (1) the inspection of home-grown nursery stock which becomes the subject of interstate commerce, or (2) the inspection of nursery stock imported from foreign countries.

The final report of the nurserymen is to the effect that the Nurserymen's Association refused to entertain any further consideration of a national inspection law, or to endorse any efforts toward securing one. (JOURNAL OF ECONOMIC ENTOMOLOGY, August, 1908, Vol. 1, pages 270–273). The association did, however, indorse thorough inspection of imported nursery stock at final destination of latter. This report is signed by Orlando Harrison, a prominent Maryland nurseryman, as chairman of the committee on national inspection law.

Mr. Harrison reports, however (*l. c.*, p. 271), sending out 460 letters in May, 1908, chiefly to nurserymen throughout the country, inquiring their wishes as to the enactment of a national law governing the inspection of both imported and home-grown stock. Two hundred and twenty-five replies were received, of which from nurserymen, one hundred and seventy were in favor of a national law, twelve against, and five neutral. Of the entomologists and inspectors of different states, out of thirty-three replies, only two opposed. This is interesting as showing the general attitude of nurserymen of this country. The objecting nurserymen, however, seemed to be the influential members, and were able to shelve any possible recommendations looking toward legislation. Furthermore, the resolution at the convention of nurserymen that year (June 10–13, 1908), indorsing the passage of a law by Congress providing for government inspection of all *imported* nursery stock, was shelved by reference to Mr. Pitkin of New York, chairman of the committee on national legislation, who made no further report on it. It may be noted that Mr. Pitkin and his conferees in New York are leading importers, and have persistently opposed such legislation as will be indicated later. This was the end of the attempt to secure legislation which had been under way since 1897.

The further attitude of the legislative committee, under the chairmanship of Mr. Pitkin of New York, is shown by the following records: With the renewed effort to obtain legislation in 1909, caused by the

discovery that the brown-tail moth nests were being brought into this country in enormous numbers on imported nursery stock, the legislative committee of the nurserymen, under the chairmanship of Mr. Pitkin, came to Washington to oppose the bill which had already passed the house and was before the senate for consideration, and would undoubtedly have become a law in due course. The committee made representation that it was not opposed to such legislation, but wished to have the bill amended in certain features to make it meet the needs of the importers of nursery stock. Under the supposition of an honest intention on the part of the committee, to this effect, the chairmen of the Agricultural Committees of the house and senate, respectively, consented to withdraw the bill for such amendment, with the idea that it would be submitted for enactment before the next session of Congress.

The actual attitude of this same committee is shown by the report of the committee, published in the *National Nurseryman*, for July, 1909, page 209. Chairman Pitkin says, "The chairman of the committee called to his assistance Messrs. Irving Rouse, James M. Pitkin, J. H. Dayton, Abner Hoopes, W. H. Moon, and Thomas B. Meehan, and the committee went to Washington and succeeded in *killing* the measure for the last session of Congress." A draft of a measure suitable to the nurserymen was submitted (same publication, pages 212–213). This draft is based on the "killed" measure, but the latter is so emasculated as to very much decrease its usefulness. For example, the substituted bill proposed by the Committee of the American Association of Nurserymen omitted (1) inspection in the country from which the importation is made, (2) the indication of the country or district in which the stock is grown, (3) provision making fumigation or inspection at the expense of the owner or consignee, (4) the provision for placing under quarantine, so far as any particular kind of plant is concerned, any foreign district where such plant is known to be infected with a dangerous insect pest or plant disease, not now in this country, and, (5) other sections weakened by the omission of necessary certificates and a penalty for counterfeiting or willfully altering same.

With the taking up of the subject of this legislation in the succeeding session of Congress, the same committee of nurserymen was called before the House Committee on Agriculture at Washington, in April, 1910, and a full hearing was given on the measure, nurserymen, state entomologists, and individuals representing agricultural and horticultural societies appearing before the committee. The chairman of the nurserymen's committee, Mr. Pitkin, stated in the published hearings of the committee (p. 75): "I am glad

to say, however, that we have not come down here to antagonize the principle of inspection and control. I am glad to see from this discussion that we are united upon the principles for which this bill stands. We have a little difference of opinion as to the best methods to be pursued, and these I believe are honest differences of opinion, and we ought to be able to get together"; and he continues in the same vein.

This sounds fair enough, but in his signed report with other members of the committee, published in the *National Nurseryman* for May, 1910, page 598, he says: "A hearing was granted by the House Committee on Agriculture at Washington on April 27 and 28, and your committee appeared at the hearing and made the strongest argument possible, first against the bill; second, suggesting some amendments and modifications if it were determined by the committee (House Committee on Agriculture) that some legislation is necessary."

It is evident that this nurserymen's committee, in spite of its fair promises, is first and foremost *against* legislation. In its report, referred to above, this committee advises every nurseryman in the country to immediately write to the Committee on Agriculture, protesting "in the strongest terms against the adoption by this committee of House Bill 23252, on the special ground that the power and authority granted by section 8 is liable to create abuses, and that the nursery interests in the country do not feel safe in placing in the hands of any federal official, such absolute control over the seedlings, the raw material of the nurseryman, from which fruit trees are produced."

The final action of the importing nurserymen, referred to in the introduction, blocked legislation at this session, notwithstanding that section 8 of the bill was to have been modified to meet the objections voiced in the last paragraph. This completes the chapter of the attitude of these importers, and presents the picture of this small commercial interest, for the moment checking legislation which is bound to come, and which will in the end be just as useful to nurserymen as it will be to fruit growers and forestry interests.

Published by the Legislative Committee of the American Association of Economic Entomologists.

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J. B. SMITH,
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TREATING SEED CORN FOR WIREWORMS

By H. T. FERNALD, *Amherst, Mass.*

A previous number of this JOURNAL (II, No. 4, 279, 1909) contained a note referring to experiments for the purpose of protecting seed corn from wireworms. In that note it was stated that the tests had progressed to a point where it seemed desirable to repeat them on a larger scale, and in different parts of the country.

During the past year, reports of quite a number of these tests have reached the writer, and have indicated a wide difference in the results obtained, some reports being very favorable, while others condemn the method in the most unqualified terms. To reconcile, if possible, these results, considerable correspondence has been necessary, but the final outcome has suggested certain factors as being responsible where failure was reported, and these are here considered.

In all the cases where the treatment was reported as unsuccessful, the failure of the seed to germinate was the nature of the complaint. This seems to have been caused by one of several reasons. Some experimenters appear to have used coal tar instead of gas tar, which may have been the cause. At Amherst, gas tar from the town gas works was the material used. In other cases, the tar was applied without thinning, and thus probably coated the seed with a layer so thick and impervious to water that it was impossible for germination to occur. In the original experiments the tar was mixed with linseed oil until it was quite thin, and under these conditions, all the seeds germinated.

Some experimenters apparently coated the tarred seed with Paris green unmixed with road dust, or any other diluent. While this would probably have no effect upon the germination of the seed, it is, at least, evidence that complaints which come from persons who do not follow directions, may be the result of failure in any of a number of points besides the one or ones actually ascertained.

On the whole, the method suggested can hardly be considered a failure, in spite of the criticisms it has received, until further tests, following the correct method, shall have demonstrated its worthlessness.

During the past season a modification of the above method has been tried with some success. Mr. R. D. Gilbert of the Bowker Insecticide Company, Mr. R. H. Whitcomb on whose farm and by whom the experiments were conducted, and the writer were all concerned in these tests, and desire to carry them further.

This method obviates the necessity of two treatments of the seed, first with tar and then with Paris green, by using a paste arsenate of lead. In the particular experiments here reported, Disparene

in paste form was used. This was first diluted to about the consistency of paint. The seed was then placed in this and stirred about till thoroughly covered, then spread out to dry before being planted.

Unfortunately the wireworms were not so abundant in the fields planted, as to give an entirely satisfactory test, though some were present. The germination of the corn treated in this way was all which could be desired; none of it was attacked by the wireworms which were present, and a good stand of corn was obtained. It would now seem desirable to test this method where wireworms are very abundant, to ascertain just how effective it is against these pests, and it is planned to do this the present year if infested fields can be obtained. It is desirable, also, to repeat these tests in other parts of the country, and this article is published now in the hope that the method will be tested in many places, and the writer will be glad to learn of results, from which final conclusions as to the value of this treatment can be drawn.

NOTES ON SOME INSECTS INJURIOUS IN NEBRASKA IN 1910

By MYRON H. SWENK, *Lincoln, Nebraska*

During the past season several cases of insect injury to field crops of a severe or unusual character have engaged the attention of the Nebraska entomologists, some of which will possibly be worth recording. Among these was the yellowing and dying out, frequently to a distinctly serious extent, of the winter wheat during latter October, 1910, in eastern Nebraska, due to the attack of wheat-root aphids. This injury was not confined to a limited region, but covered the territory south of the Platte west to Buffalo and Kearney counties and northward about to Burt County, thus including most of the wheat-growing area in the state. Although the impression prevailed that the Hessian fly was chiefly responsible for this discoloration and dying out of the wheat, and, in fact, that pest was seriously injurious in the early sown fields, our investigations showed that two other factors were also operating to produce this same effect and that in many fields these latter factors were the chief and perhaps the sole cause of injury. One of these was wheat-root aphids and the other was ordinary wheat rust in an unusually severe infestation.

In some fields two, or perhaps all three, of these factors were operating simultaneously, so that it became extremely difficult, if not impossible, to accurately determine just how much of the injury was due to each, but a goodly number of late sown fields showing no considerable number of Hessian fly puparia and not rusty or severely so

as the case happened to be, still were rapidly dying out and these showed great numbers of large plump aphids clustered about the lower stem and roots, draining the plant sap. These aphids were mostly *Geoica squamosa* and, less commonly, *Forda occidentalis*, both of which have previously been recorded as minor corn pests in Illinois. Dodge, Adams and Seward counties showed particularly obvious injury, and the injured fields were not concentrated, but were scattered throughout the whole affected region, being often several miles apart, with the intervening fields not noticeably affected by either the *Geoica* or the *Forda*, though *Siphocoryne avenæ* was commonly present in small numbers in all the fields. Taken as a whole the injury was rather extensive. It first became apparent in September when small patches began dying out, and these enlarged as the fall advanced and the aphids multiplied and spread, until they involved an acre or two in extent, and, not rarely, the entire field. The wheat in the affected patches was cleanly taken and the plants were dead to the roots. The aphids continued working until late in November undergoing some quite severe temperatures. Almost invariably both these wheat-root aphids are attended by the ant *Lasius niger neoniger*. We found the *Forda* during the past winter hibernating abundantly under stones near nests of the *Lasius* and feeding upon the heavy creeping rootstocks of a grass presumably quack grass (*Agropyron repens*), at Lincoln.

The present season has not been the first that these aphids have injured wheat, though it is by far the most extensive injury we have known. Our first definite knowledge of the injurious habits of these aphids was recorded in 1907, when during April of that year Mr. H. S. Smith found the *Forda* very abundant in the wheat fields of Buffalo, Kearney and Adams counties while he was investigating reported occurrences of the green bug in that region. Although some plants supported as high as forty aphids, the infested fields on the whole were not seriously injured. In the fall of that year, October 17, Mr. Smith found the *Geoica* attacking volunteer wheat scattered through the sowed grain in Hamilton County, it being quite abundant upon the roots and causing the plants to assume a sickly yellowish green color. In 1908 the *Geoica* appeared in excessive numbers in Clay County during middle October, one farmer reporting them to be present by the millions in his wheat fields. Last year (1909) the *Forda* injured fields in several localities in Hall County, killing out the wheat in patches an acre or two in extent between middle September and latter November, and similar reports were received from Boone County in October. The present season the *Geoica* greatly predominated, being first found in Hamilton County in July, in limited numbers on corn roots with *Aphis maidi-radicis* and abundantly on the grasses in the

corn fields and then later, during the fall, on wheat over a large area in the Platte valley as just detailed. These two root infesting aphids, then, have placed themselves on record as serious enemies of winter wheat in Nebraska.

Another, and I believe unrecorded, serious enemy of winter wheat came to our notice this fall from two separate localities, from Buffalo and Holt counties, in the form of a *Cyclocephala* white grub. This injury occurred in October, and the Buffalo County infestation was fully examined by the writer in person. The same condition was common in many fields in the southeastern part of the county, namely, that the plants had commenced dying about the first of September and in the next month had died out completely or at least had only a scattered sickly stand remaining. The soil in these fields was fairly alive with the *Cyclocephala* larvæ, as I turned over fifty in a space less than two feet square and did not secure all of them. Similar, though less intense, injury has been experienced in this region during the past three seasons. We do not yet know for certain the exact species concerned in this work, as we have two common species of which it might be either, namely, *C. villosa* and *C. immaculata*. *C. villosa* is, however, much the more prevalent in the infested area, and it is probably that species.

For the past three seasons at least (1908–10) there have been more or less serious local outbreaks in the wheat and oat fields of western Nebraska of a wheat-head army-worm allied to the common wheat head army-worm (*Heliophila albilinea*), to which species we referred it until recently when a careful study of the adults proved it to represent a distinct species not heretofore recognized as a field crop pest. Dr. J. B. Smith recently examined bred moths of the western Nebraska army worm and pronounced them to be *Heliophila limitata*, a species which he had described in 1902 from a single male specimen collected in Texas in June. In 1908 and, according to reports, in 1906 also, during middle July there were local outbreaks of this army-worm in the oat fields of Deuel County near Lewellen, and in some instances the worms practically destroyed the crop by clipping off the leaves from the stem and cutting off the heads of grain, there being on the average, about one worm to each head of grain. In 1909 several localities were affected by this army-worm, especially about Trenton, Hitchcock County, Wauneta, Chase County, and Alliance, Box Butte County, but the damage on the whole was not very severe. In middle July (6 to 17) about Trenton and Wauneta, when the wheat was harvested the stubble was found infested with myriads of these worms, some of which had been in evidence upon the heads a bit earlier in the season. About Alliance the trouble was more in the oat fields, and while har-

vesting in some fields the canvas of the binder would become covered with the worms while the whole field was alive with them. The above instances of damage are recorded on the strength of examinations of the larvæ, which seem to be readily distinguishable from those of *albilinea*, except in the case of the Trenton insects where some of the arvæ were reared. The species seems probably double brooded like *albilinea*, for from larvæ received July 12 all pupated July 17 and moths emerged August 14 and September 1. Many, though not all, of the infested fields were in sod the preceding year.

The past season was the worst grasshopper year we have had for a decade in central and western Nebraska, and during July these insects were exceedingly destructive to the alfalfa, corn and oats of that section of the state. At Red Cloud, Webster County, in early August the prevailing species, *Melanoplus bivittatus*, was very heavily parasitized by an undetermined sarcophagid fly, which in turn was parasitized by the chalcid *Perilampus hyalinus*. The chinch-bug (*Blissus leucopterus*) was the most abundant in the southern counties this year that it has been since 1901 and during July injured wheat, oats and corn seriously. The corn-leaf aphis (*Aphis maidis*) this season was exceedingly abundant in Sherman County near Loup City during early August, and in some fields produced rather serious injury by killing the upper leaves, on which it had congregated by the thousands. A local outbreak of the green bug (*Toxoptera graminum*) occurred in late October near Shelby in Polk County and the wheat fields were found swarming with these aphids, but they were so heavily parasitized by the *Lysiphlebus* that no spring attack is anticipated.

SOME OLD METHODS APPLIED IN A NEW MANNER TO A COLLECTING MACHINE

By H. F. Wilson, *Oregon Agricultural College*

The included sketch illustrates a machine used by the author during the past spring for collecting hibernating insects. Jarring and heat are relied upon and a very large sifting surface is secured. Another advantage is found in the fact that the machine can be used as readily in the field as in the laboratory and without alcohol or kerosene. The bottom is flat and the machine can be set on a stove in the laboratory or placed over a trench in the field. When used in the field a piece of stovepipe should be used as a chimney in order to carry away the smoke and to keep a continuous draft under the tank.

The main box is made of galvanized iron and is 4 feet long, 2 feet high and 18 inches wide, the bottom piece being of one continuous piece soldered and riveted at the corners. This lessens the danger of melting the soldered connections. In the present case the box is braced with pieces of iron bed rails riveted around the bottom and along the corners, with a continuous band around the top; the band is of iron 1 inch x 3-16 inch. This makes a strong but light box and one person can handle it without much trouble.

The end E is made in two parts, the upper part being fastened to the lower with hinges, so that it can be lowered and ready access

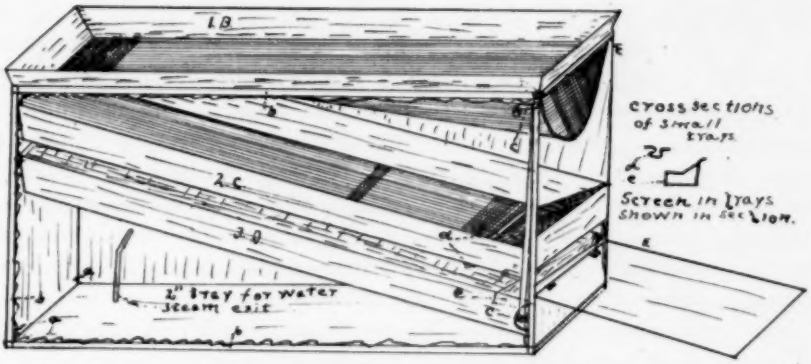

Fig. 6. Collecting machine; B. C. D, three trays; *a* upper line of the water tank; *b* iron supports of the box; *c* parts of the jarring arrangement; *d* and *e* cross trays and sections.

gained to the two lower trays. The water tank is of galvanized iron and is made in the form of an inverted tray soldered to the inside of the tank. This tray is two inches deep with an inlet hole in one corner and an iron tube connected to the outside whereby the steam is carried away.

At the end E a crank and sprocket wheels with a bicycle chain can be used to jar the trays by raising them and dropping them. At the bottom of the middle tray a round wooden piece with a raised side is run across the box and at every revolution of this piece the tray is raised and allowed to drop. The other two trays are fastened to this one and are raised and dropped at the same time, giving all of them a steady but light jar.

The top tray is made so that the ends and sides are parellel with the top and with the sides slanting inward so that the bottom of the tray is smaller than the top of the tray below. A piece is morticed in to the end and is allowed to drop about 11 inches below the end of the tray at the end E. From the other end of the tray another

piece is run to meet with that piece and around them 1-4 inch wire screen is fastened. We now have a tray that will hold about two sacks of leaves and with a sifting surface equal to nearly ten square feet.

The other two trays are made to run parallel with each other and slanting as much as possible in the remaining upright space. This should be from one inch from the top tray to within one inch of the water tank. These trays rest on a board which runs across the end of the box E and are supported at the other end by hooks which gives them a free movement for jarring. This cross board also acts as a base for them to fall upon when they are dropped by the turning of the jarring wheel.

Tray 2, as shown in the diagram, is made with two pieces of 1-8 inch wire screen. One piece running from the top of the upper edge to within 8 inches of the lower side at the bottom. The second piece runs from the top of the lower side to within an inch of the other piece and so leaves an open space of one inch running transversely across the box. A small tray of tin is fastened across this opening, the sides being rounded as shown in the illustration. The ends are of tin and are soldered so that the insects cannot escape, most forms being unable to crawl up the tin surface. This tray is fastened in place by reversible clamps and can be removed by lifting up the tray. The insects thus caught can be transferred to something else and the tray returned to its place with but little loss of time.

Tray 3 is made so that the carrying part is of tin, one inch deep, open at the lower end and overlapping a cross tray. The tin part is placed so that it is about even with the top of the carrying frame and reaches to within two inches of its lower end. At the bottom of the main tray a shelf is placed to hold a cross tray three inches wide which underlaps the main tin tray and catches all that falls into it. This tray is made to fit squarely into the wooden tray and can be removed by raising up the middle tray.

The lower cross tray will necessarily catch all the rubbish and small particles of sand that fall through the upper trays but the author was able to separate out the insects by gently pouring the contents of the tray into a tub of water. The sand and dirt would sink to the bottom while the insects would be held on the top film of water. To what extent this would apply it is hard to say as mites only were considered in our experience.

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OFFICIAL ORGAN AMERICAN ASSOCIATION OF ECONOMIC ENTOMOLOGISTS

APRIL, 1911

The editors will thankfully receive news items and other matter likely to be of interest to subscribers. Papers will be published, so far as possible, in the order of reception. All extended contributions, at least, should be in the hands of the editor the first of the month preceding publication. Reprints may be obtained at cost. Contributors are requested to supply electrotypes for the larger illustrations so far as possible. The receipt of all papers will be acknowledged.—Eds.

Efficiency engineering is the application of scientific principles to ascertain the most economical method of accomplishing a given task. Economic entomologists have been from the very first, efficiency engineers in their own fields. Some of our mechanical and agricultural colleges may yet give the degree of E. E. E.—Efficiency Engineer in Entomology. The primary burden of the economic entomologist is to demonstrate possibility; next comes economy in execution. The symposium on spraying in this number is a notable contribution to this phase of efficiency engineering. The spraying apparatus of early days was planned for very different work and there was little adaptation to the special conditions obtaining in the field. A number can recall the hand outfits used in the ear'y days of the gipsy moth work. Compare them with the present high power outfits capable of spraying forest land for less than $7 an acre—a figure way below possibilities with hand labor. The ample power, heavy hose and solid stream nozzle represent a stage in the development of an efficient spraying outfit. No one dares to say the limit of efficiency has been reached. The solid stream, while well adapted to certain phases of woodland work, is open to serious criticisms. A considerable amount of poison is wasted even with the most skillful handling. The impossibility of closely controlling the applicationof the spray militates strongly against its general employment in shade tree work. A mechanical extension nozzle operated from the ground and capable of rapid and extensive modification in height, direction and character of spray, is an important desideratum. The unusually long extension nozzle on universal bearings, used in the roadside gipsy moth work, is a step in this direction. One manufacturer has put on the market a mechanical spray tower which needs testing out and probably some improvement. The

grandest field laboratory for the study of spray efficiency is to be found in the gipsy moth infested territory of eastern Massachusetts, with its hundreds of outfits of widely varying types. There is an excellent opportunity in this section for additional studies of spray efficiency. This is not to be construed as an implied criticism of the past with its admirable record of achievement, but a suggestion as to profitable lines of activity in the future.

There is another problem in woodland work deserving of serious consideration, since economy of treatment is perhaps the most vital factor in such an undertaking. There have not been to our knowledge, any careful studies as to the results which may by obtained from applications to portions of trees, aside, perhaps, from the data gained in an incidental way in the early days when it was impossible to spray the tops of tall trees. There is abundant evidence to show that a number of our leaf-feeding pests will destroy the tops of trees unless they are well protected by poison. We recall nothing that establishes the efficiency or relative inefficiency of applications to the foliage of only the upper portions of trees, a place where a number of our leaf feeders begin operations and one where it would seem that many might be destroyed with a minimum expenditure and before serious injury had been inflicted.

The recent action of Andrew Carnegie in placing at the disposal of the African Entomological Research Committee the sum of £1,000 for three years to defray the expenses of sending suitably qualified young men to the United States for the purpose of studying the practical applications of entomology is a gratifying recognition of the excellent work which has characterized American investigations. No country at the present time expends so much upon economic entomology as America, and nowhere can be found such a corps of experts. The enormous development in recent years has been the outcome of a greatly increased demand for protection from injurious insects. With a better understanding of the practicability of checking insect enemies, there will be progressive calls for more service. These can be met satisfactorily only by retaining in this branch of science the most able and original workers. Such, in the long run, can not afford to devote their entire energies to a field offering inadequate compensation. It is a lamentable fact that, despite the enormous growth in demand for entomological knowledge in the past few years, there have been very few increases in the number of really desirable positions, while a canvass of the situation would show that the recognized leaders in economic work are receiving very inadequate com-

pensation. The ultimate outcome of a continuance of such conditions is bound to result in deterioration, since many of the more progressive investigators will turn to fields with better promise of financial returns and affording equal opportunities from a scientific standpoint. Many admirably trained college graduates have taken up entomological work within the last decade, and several schools now have their resources taxed to the uttermost to meet the demand of those who desire to enter this field. Even with this additional supply of workers it is impossible to secure qualified assistants at prices which were considered ample ten years earlier. Many of these men with their years of experience in special work must soon find positions offering more than their present income, or entomology will lose some of its most capable students. This would not be serious if there were no need of their services; but the contrary is true. There is greater apparent and potential need today of practical knowledge relating to insects than was the case twenty years ago and the demand for such is bound to increase. This condition must be reflected in the opportunities of advancement both professionally and financially or retrogression is inevitable. The former must prevail. The latter is unworthy of a progressive nation dependent in large measure upon the prosperity of the agricultural interests.

Bulletin of Entomological Research.—The appointment in 1909 of an entomological research committee for tropical Africa augurs well for the future welfare of the Dark Continent, since it implies a more adequate recognition of the important part insects play in the dissemination of tropical infections. The representative committee upon which this burden was laid, proceeded at once to organize the work and, as one of the results of their activities, we have the above mentioned bulletin, the first number being issued about a year ago. This new publication naturally concerns itself largely with mosquitoes and Tsetse flies, species of which are among the most active and dangerous disease carriers, though an examination of the contents of the four issues shows that those responsible for this venture are taking a broad view of the situation. The original studies are not closely limited to species of known economic importance, but include allies and forms likely to be confused with the dangerous pests. Moreover, those affecting agricultural and other products valuable to man, are given due attention. The work is of necessity pioneer in nature and a large number of interesting species are bound to be discovered. We confidently expect that the systematic study of African entomology will result not only in large additions to knowledge, but in a material gain in information of immediate practical value. We take this opportunity of commending the auspicious beginning of what will undoubtedly prove to be a magnificent undertaking. There is great need of similar work in American tropics. A beginning has already been made though it can hardly be characterized as a systematic and comprehensive study of the problems involved.

E. P. Felt.

Reviews

The Grape Root-Worm, by FRED JOHNSON and A. G. HAMMAR. U. S. Dept. Agr., Bur. Ent. Bul. 89, p. 1–100, figures 31, plates 10. 1910.

This is another comprehensive bulletin based on the work of a series of years. The thorough biological studies summarized in a series of tables leaves little to be desired. Particular attention was given to the behavior of the insect from year to year, and the effect upon it of varying conditions. The life history of the egg parasite, *Fidiobia flavipes* Ashm. was carefully worked out and an unknown, supposedly dipterous egg parasite discovered. One of the most gratifying phases of the work was the obtaining of unquestioned evidence as to the value of thorough spraying with an arsenical poison for the control of this serious pest. Emphasis is laid upon the necessity of an early application so as to reach the beetles just after emerging from the soil, since they appear to feed much more freely at this time. A second spraying is advised 10 days after the first. The destruction of pupæ is recommended whenever conditions are favorable. The data relative to the renovation of badly injured vineyards is a practical phase which will appeal strongly to the grower. There is an extended bibliography. The effectiveness of the bulletin is greatly enhanced by an admirable series of illustrations. The authors are to be congratulated upon having made a substantial addition to our knowledge of a very destructive insect pest.

Life History of the Codling Moth in Northwestern Pennsylvania by A. G. Hammar. U. S. Dep't Agric., Bur. Ent., Bul. 80, Prt. 6, 1910, p. 69–111.

This contribution summarizes in very small compass the results of three years investigations of the codling moth at North East, Pa. Aside from the new facts submitted, entomologists will be interested in the illustrations of methods, such as the handy device for studying the duration of the pupal period and the outdoor shelter used in rearing work. Both may be of material service to investigators. The studies of the pupæ show that this stage may extend from fifteen to thirty-four days, the average being nearly twenty-two. Table VI shows that the moths emerge between 7 a. m. and 1.30 p. m., while the length of adult existence ranges from seventeen to nineteen days, the average being a little over eleven. The author concludes that the larvæ are frequently cannibals, since rarely more than one attains maturity in an apple, though observations show that a great number may enter the same fruit. A summarization indicates that transforming larvæ may feed from seventeen to thirty-seven days, an average of twenty-six and one-third days, while overwintering larvæ may extend their feeding time to fifty-five days with an average of a little over thirty-one days, approximately 70 per cent of the first brood hibernating. The exact data on the appearance of moths and the deposition of eggs will be of great value in determining the period when spraying can be done to best advantage. Overlapping of the broods and the various stages of each is graphically shown in figure 22 and illustrates the difficulty of laying down hard and fast rules for the control of this insect, particularly when it is remembered that there is more or less variation from year to year. The value of the bulletin is greatly increased by including therein local weather records during the growing season for the three years. The author has made a notable

addition to our knowledge of this pest and it is to be hoped that here we have only one of a series of local studies which should be made in representative sections of the country, not only of the codling moth, but also of other insect pests.

The One Spray Method in the Control of the Codling Moth and the Plum Curculio by A. L. Quaintance, E. L. Jenne, E. W. Scott and R. W. Braucher. U. S. Dep't Agric., Bur. Ent., Bul. 80, Prt. 7, 1910, p. 111–146.

The results given in this paper are exceedingly interesting, since they are the outcome of experiments conducted under the same general plan in widely separated sections of the country. Comparisons were made between one thorough application, under high pressure, of a bordeaux mixture poisoned with arsenate of lead, subsequent treatments being restricted to the application of fungicides, and demonstration spraying which consisted of five poison applications, all except the first being mist sprays. These two in turn were compared with unsprayed or check trees. The arrangement of the plots and location of the trees from which data were taken was not ideal, though the results do not appear do have been materially affected. The summary shows that so far as the control of the codling moth was concerned, there was not very much difference between one spraying and the demonstration treatment where approximately two thirds or more of the fruit on unsprayed trees were sound, the variation being only from 4 to over 5 per cent in favor of repeated spraying. On the other hand, there was considerable advantage in several applications of poison where only about half of the fruit on unsprayed trees was free from codling moth injury, the difference in their favor being approximately 10 per cent in one case and in the other instance only about 1 per cent. Being unacquainted with the reasons for this marked discrepancy in the latter instance and the authors throwing no light thereupon, we can only hazard the suggestion that the uneven character of the land as shown on Plate 10, figure 2, may have been a factor in reducing the efficiency of the treatment. There were in all sprayed plots, as was to be expected, substantial benefits resulting from the treatment. Such repeated applications are of comparatively little value in controlling plum curculio, as shown by the fact that in two plots sprayed but once there was a larger percentage of fruit free from injury by this insect, while the remaining two plots, receiving the demonstration treatment, were only slightly less affected than those sprayed but once. There was material, and in the case of one plot, a very great difference in favor of poisoned applications as compared with no treatment at all. The authors' results with the single spray against the codling moth agree in a general way with those secured by the reviewer. Obviously, there cannot be a material saving with one application of poison in sections where several treatments are necessary for the control of other insects or fungous diseases. It is a fact that certain of our fruit-growing sections, at least, are moderately free from insects which cannot be kept in check by thorough annual sprayings at the time when such treatment would be most effective in controlling the codling moth, and where there is little likelihood of serious trouble from fungous infection. These considerations justify an exhaustive study of the possibility of controlling insects and fungous diseases on fruit trees with one timely and thorough spraying.

Apple and Pear Membracids by H. E. Hodgkiss. N. Y. Agric. Exp't Sta. Techn. Bul. 17, 1910, p. 81–112.

This publication is a marked addition to our knowledge of four rather common species, one of which at least has been very frequently mentioned in economic litera-

ture. The life histories of *Ceresa bubalus* Fabr., *C. taurina* Fitch, *C. borealis* Fairm. and *Stictocephala inermis* Fabr. have been carefully worked out and the various immature stages fully described and admirably illustrated. The economic status of each species is discussed and the value of the publication materially increased by complete bibliographies.

First Report of Economic Biology by Walter E. Collinge. The Midland Educational Company, 1911, p. 1-74.

This report gives short, and, for the most part, illustrated notices of a considerable number of injurious species depredating upon farm and garden produce, fruit trees, forest and ornamental trees and those preying upon animals. There is in addition, one chapter discussing fungous diseases. The American entomologist will be particularly interested in the accounts of species established in America or likely to be brought to this country, such as the bulb mite, *Rhizoglyphus echinopus*, the bulb scale, *Ripersia terrestris*, besides such well-known pests as the pear midge, blister mite, etc. It is a pleasure to commend in particular the excellent process reproductions of admirable photographs.

Current Notes

Conducted by the Associate Editor

A fellowship has been established in Cornell University, College of Agriculture, for the investigation and control of the fungous diseases and insect pests of the orchard crops of Batavia, N. Y., by the fruit growers' association of Batavia, and provides for two fellows, one in entomology and one in plant pathology.

The work announced for the Lake Laboratory of the Ohio State University for the coming summer includes a course in entomology and the opportunity to conduct research work in problems upon insect life. The laboratory is at Cedar Point on Lake Erie in an exceptionally favorable locality. The entomological work will be in charge of Professor Osborn, Invertebrate Zoölogy under Professor Brookover and Ecology under Professor Jennings, all including matter which is of distinct interest to entomologists with the privilege of free tables to investigators. The session opens June 19, and additional information as to particular courses or the general announcement may be obtained upon application to the director.—Herbert Osborn, Ohio State University, Columbus, Ohio.

J. L. Phillips, formerly state entomologist of Virginia, with headquarters at Blacksburg, is now located at Staunton, Va., and has opened an office as consulting orchard expert.

Dr. Henry Skinner has been giving a course of lectures in the Ludwig Institute of the Academy of Natural Sciences, Philadelphia, Pa., covering the whole field of entomology, but emphasizing especially its medical aspects.

At the University of Colorado a State Biological Survey has been organized under a committee consisting of Professors T. D. A. Cockerell, Francis Ramaley and J. Henderson. An investigation will be made of the fossil and living plants and animals of the state.

Science states that according to Reuter's Agency the British South Africa Company has decided upon the despatch of a special commission to investigate sleeping sickness in Rhodesia. The commission will consist of Dr. Aylmer May, principal medical officer of northern Rhodesia; Dr. A. Kinghorn, of the Liverpool School of Tropical Medicine; Doctor Leach of the northern Rhodesia Medical Service; Mr. O. Silverlock, entomologist, and Mr. Jollyman, bacteriologist.

At the Oregon Agricultural College a Biological Club has recently been formed, the charter members consisting of the Bacteriology, Zoölogy, Entomology, Botany and Plant Pathology departments. The object of the organization is to promote interest in the various subjects, both systematic and economic, which will fall under the various departments.

The Oregon Legislature at its last session appropriated the annual sum of $15,000 for the purpose of investigation of crop pests. This fund is to be divided into three parts; the Entomology, Horticultural and Plant Pathology departments each receiving a third. This is for the purpose of carrying on experimental work upon all economic problems within the state, and is probably the first appropriation made in any state for such a purpose alone.

The people of the Hood River Valley, Ore., have entered upon a coöperative plan whereby an expert furnished by the college, but whose salary will be paid by the Hood River fruit growers, will be stationed at Hood River. The duties of the expert will be to investigate such insect pests and plant diseases as become injurious to the fruit orchards. This expert is Prof. W. H. Lawrence, formerly director of the Puyallup sub-station of the Washington Experiment Station.

Upwards of 150 students are at present enrolled in the various classes in entomology at the Agricultural and Mechanical College of Texas. This is the largest enrollment in the history of the department, and has been brought about both by the increased attendance at the college and the constantly increasing number of students taking up agricultural subjects. The teaching force of the department consists of Wilmon Newell, professor; E. E. Scholl, assistant professor, and Harper Dean, instructor.

The enrollment in entomology the present term at the University of California is 426. Eighteen different courses are offered during this semester. The largest classes are in general entomology, ecology, apiculture, medical entomology and spraying, showing that the purely economic subjects are given the preference by students.

Mr. J. C. Bridwell will spend the next six months in southern California, largely in the Imperial Valley, and Prof. H. J. Quayle, who has been assigned to investigation work the last three years at Whittier, has returned to Berkeley and resumed his class work.

Prof. E. W. Berger, entomologist of the Florida Agricultural Experiment Station, gave a talk, illustrated by lantern slides, before the American Pomological Society in session at Tampa, Fla., on the evening of February 10, 1911.

E. F. Hitchings, state entomologist of Maine, has been appointed professor of horticulture at the University of Maine, at Orono. He will continue to hold the position of state entomologist.

Mr. T. D. Urbahns, instructor in entomology at the Minnesota Agricultural College, has resigned to take up an investigation of the alfalfa weevil for the Bureau of Entomology, and will be located at Salt Lake City.

The January issue of *Agriculture*, published monthly by the Association of Agricultural Students of the University of Nebraska, is an entomological number which will doubtless prove of interest to many of our readers, since it gives a summary account of the development of the Department of Entomology, including a discussion of its present activities.

Mr. D. L. Van Dine has left the employ of the Sugar Planters' Association at San Juan, Porto Rico, and is now entomologist of the Estacion Experimental de Azucar, Rio Piedras, Porto Rico, where corresponsdents should address him.

The advance of the boll-weevil into Alabama, occurring during the fall of 1910, has already exerted a strong influence in leading planters to adopt more improved methods, not only in the culture of cotton, but with other crops as well. The press of the state has shown a most commendable desire to help in the campaign of progress and the leading papers are anxious to publish agricultural matter.

The Alabama Legislature, now in session, has been sufficiently impressed to appropriate $27,000 for 1911, and twice that amount for each of the succeeding three years for the enlargement of the Experiment Station work. This is the first direct appropriation that the state has made to the Experiment Station. With this general awakening, and the open-minded attitude of the planters and business men, Alabama stands some chance of suffering less from the advance of the boll-weevil than have most other states into which it has spread.

Miastor larvae. —These remarkably interesting larvæ reproduce by pedogenesis, are available for laboratory work to a marked degree and must be widely distributed as well as allied forms. Very little is known concerning American species, largely because their habitat is one rarely explored by entomologists. They breed mostly in decaying vegetable matter. We have been very successful in finding them under partially decayed chestnut bark of stumps, fence rails and sleepers which have been cut one or two years earlier. European species occur under the bark of a variety of trees and even in sugar beet residue: These Dipterous maggots with diverging antennæ and a fuscous ocular spot in the first body segment, have a flattened, triangular head quite different from the strongly convex, usually fuscous head of the Sciara larvæ occurring in a similar environment. They have a length of from one-twentieth to one-eighth of an inch and may be found in colonies containing a few large, white larvæ with numerous smaller, yellowish individuals, the latter being more common at the present time. Early spring with its abundance of moist bark appears to be the most favorable season for finding the larvæ. The writer would welcome the coöperation of entomologists and others in searching for these forms in different parts of the country. He will be pleased to determine specimens found under various conditions, make rearings therefrom if possible, and thus add to our knowledge of the subfamily Heteropezinæ, a group which should be fairly abundant in North America and one deserving careful study. E. P. Felt, *Albany, N. Y.*

Mailed, April 17, 1911.